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The WELDING Journal

The Journal of the American Welding Society

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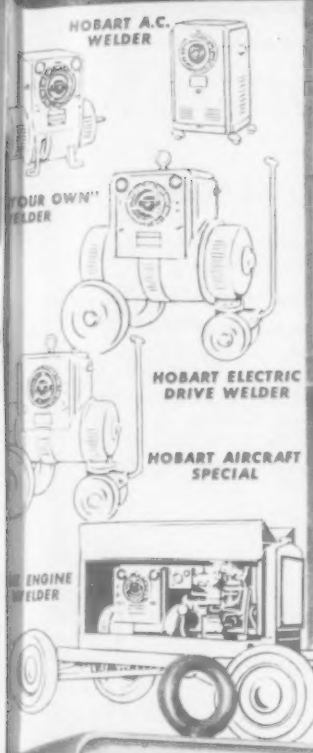

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Published for the Advancement of the Science and Art of Welding

W. SPRARAGEN, Editor

JUNE, 1944

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COVER

Stainless Steel Navy Cargo Plane.
Courtesy Edward G. Budd Manufacturing Co., Philadelphia, Pa.

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Fabrication and Welding of Exhaust Manifolds*

By C. D. LaFond and J. R. Plautz†

THERE are many varied problems connected with the design, tooling and manufacturing of a modern aircraft exhaust system. While the purpose of this paper is to deal primarily with the manufacturing and welding phase of this particular product, it may be of some interest to review briefly the problem from the designer's viewpoint.

The designer has, through the medium of welded construction, the opportunity to control to a great extent, the simplification of the structural design and tooling problem involved in producing the detail parts, the conservation of critical materials required to produce these parts and the adaptability, in general, of the design as a whole, to good sound manufacturing practice. Bearing in mind that such items are definitely controllable and having arrived at a design that is basically sound, the primary problems then confronting the manufacturer are the construction of the tools involved to produce the particular manifold in question, and the setting up of definite practices relative to the control of the structural and metallurgical properties of, for the sake of this paper, stabilized 18-8 stainless steel.

Since in our method of manufacture, all section stampings are produced on hard dies in either double-action presses or single-action presses equipped with air cushions, and since as a general rule, it is not practical from a tool cost standpoint to machine these dies on contour duplicators, we use the following methods to produce them.

We first produce a full-size master layout on sheet metal. We then make a hard wood master model of the complete job. From this model, we make our final determination of parting lines and draw surfaces. The next step involves pouring of die plasters; the females being poured directly from the model. From these female die plasters, cerrobend die spotting blocks are poured. The die plasters are then reset for shrinkage and plaster punch patterns are poured. The majority of our draw dies are made of flame-hardening alloy cast iron. After casting, the female die is spotted into the cerrobend spotting blocks, and the punch then cleared for metal thickness. The blank holder of course, being matched at metal thickness to the draw surface of the die. These dies, when finished and ready for production, are capable of producing from 10,000 to 15,000 stampings without major reworking, and, depending on the type of press used and the nature of the panel to be drawn, produce at the rate of from 100 to 400 panels per hour.

The actual drawing operation and processing allied to it present no particular difficulties. The same techniques required in producing any drawn article from this type of material are employed in producing manifold stampings. They can be summed up briefly as follows:

I. Close material inspection and control: It is our standard practice to perform the following routine tests on each heat of material we receive prior to release from steel stores:

1. Rockwell hardness.
2. Erichsen cup.
3. Tensile strength.
4. Strauss embrittlement.
5. Weldability determination.

II. Stainless steel requires larger draw radii, greater blank holding pressures and finer finish on drawing radii and surfaces than mild steel.

By the combination of draw beads, blank holder-pressure and draw radius, it is possible to obtain stampings having a minimum reduction of metal thickness in crotches and sharp radius corners. All three of these controllable items are, of course, determined to a great extent in die tryout, and are not readily definable except in a broad sense. It is our standard practice to cast all draw radii sharp, and to cast a single draw bead entirely around the panel approximately $^3/_4$ in. from the draw edge. The finished radii and draw bead locations then being determined by actual drawing conditions at the time of die tryout.

III. Ram speed should not exceed 75% of that used for mild steel with, roughly, 30 ft. per minute set as maximum for difficult shapes. While the material itself unquestionably exhibits a greater percentage of elongation than mild steel, I believe that the higher frictional characteristics of the alloy offset this apparent advantage and definitely limit the speed of drawing without excess breakage and serious pickup.

IV. Selection of a proper drawing compound is definitely essential to the successful press working of stainless steel. Although we find that while drawing compounds containing graphite produce the best results, the difficulty of removing the solution limits their use. Considering the fact that it is of prime importance to remove all drawing compound prior to annealing, in order to prevent surface pitting, and the possibility of carburization, we have made it a general practice to use a drawing compound containing water-soluble oils and a nonmetallic filler, which is readily removable in high-pressure spray-type washing machines using only hot water as a cleansing agent.

V. Full temperature must be reached in interstage

* Presented at the Annual Meeting, A.W.S., Chicago, Ill., Oct. 18 to 21, 1943.
† Buhl Stamping Co., Detroit, Mich.

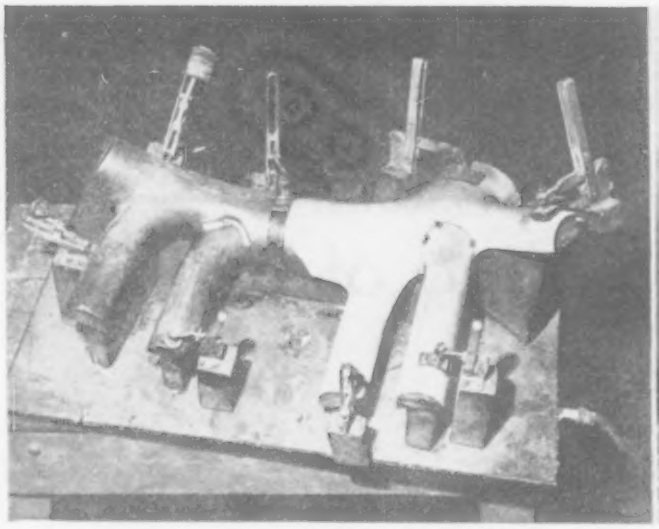

Fig. 1—Fixture Used in Arc Tacking Overlap Joints

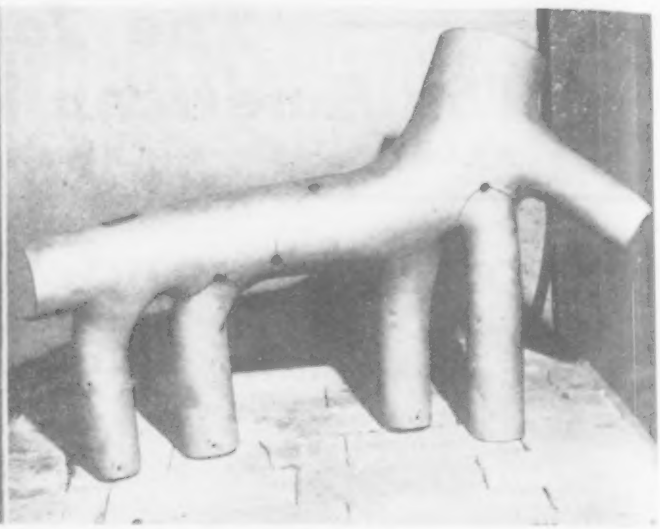

Fig. 2—Two or Three Tacks Are Sufficient to Tie Panels Together for Welding

annealing in order to insure maximum ductility. Due to the fact that our stampings in the body sections of manifold are as a rule full draws, we have found it advisable to rough trim the stampings, fully anneal to remove all draw strains and then restrike them in the draw die for final set. This practice eliminates, to a great extent, undue distortion in our tacking and welding operations.

The annealing of stainless steels, of course, results in the formation of a very tenacious scale, consisting of the oxides of chromium and iron. This scale presents difficulties in connection with the subsequent welding operations and necessitates the inclusion of pickling operations at this point. The operations involved are those generally employed, namely, approximately 30 min. in a 21% sulphuric acid solution at 130° F. followed by a cold water rinse. Then 10 min. in a solution of 20% nitric acid and 4% hydrofluoric at 110° F. This is followed by a scrubbing operation in warm water, to remove any residual smudge. The panels are then dried in a hot air furnace and are ready for trimming and assembly.

The trim lines on the various panels are marked from internal templates and either band sawed or nibble sheared to the trim lines. They are then burred on sand wheels and sent to the tacking department.

In the welding assembly of the vast majority of manifolds now in production in our plant, the first welding operation is that of arc tacking the overlap joints of all inserted port legs. The fixture used for this operation is shown in Fig. 1. It is cast from a plaster pattern—the material used being gray iron—and bearing points are spotted into the reverse punch patterns. The tacking is done with coated electrodes, and d.-c. welding machines are used. As a rule, two or three tacks are sufficient to tie the panels together since the following operation securely spot welds the two panels together, as shown in Fig. 2, and sets up an ideal arc-welding condition. This arc-welding operation is done in fixtures similar to that shown in Fig. 3, using the same type of electrodes and machines as those used in the tacking operation. The fixture is set up to allow the operators to weld in as near a horizontal position as possible. The back-up block is of cast copper, and allows greater heat to be used, thereby increasing the speed of the operation, and at the same time reducing the possibility of burn-through. A sample panel from this operation is shown in Fig. 4. The tacking of these partial assemblies

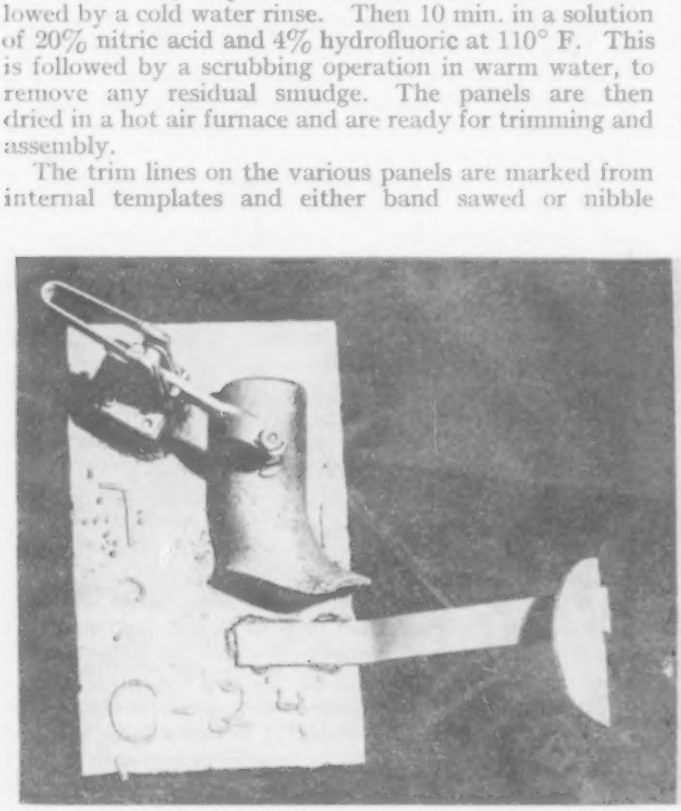

Fig. 3—Fixture for Arc-Welding Operation

Fig. 4—Sample Panel After Welding

Fig. 5—Fixture for Assembly of Sections

to form the welded section assembly, is done in fixtures similar to that shown in Fig. 5. The parts are acetylene tacked on $1^1/_4$-in. centers, removed from the fixture and any misalignment of the butt edges is corrected by hammering on special mandrels, such as those shown in Fig. 6. The final weld is made in fixtures which position the panels, thereby enabling the welders to perform practically all work in the flat. No attempt is made to rigidly hold the panel dimensionally during this welding operation; very little distortion is encountered, however, due to the fact that the stampings themselves are fully stress relieved prior to welding and to the development of a definite welding procedure best suited to each individual assembly.

Following the final seam weld, all sections are heated to 1950° F. and held at this temperature long enough to insure a thoroughly uniform temperature throughout the section. They are then pickled, using the same process previously described. The section assemblies are now ready for the final trim fixture, a typical fixture is shown in Fig. 7. The trim lines are scribed from the fixture faces. The assembly is then removed from the fixture and saw trimmed to the scribed lines. The final sizing of port legs and body section ends, both beaded and plain, is done in hydraulic expanding machines. These machines are designed to allow for rapid interchangeability of both internal and external sections, and produce diameters accurate to ± 0.005. After sizing, the parts are placed in the final assembly fixtures. These fixtures are identical in design to the trim fixtures with the exception of the port leg locators. All final fitting is done in these fixtures. Port connection nipples or brackets are arc tacked or welded in place and the port legs adjusted to the engine exhaust

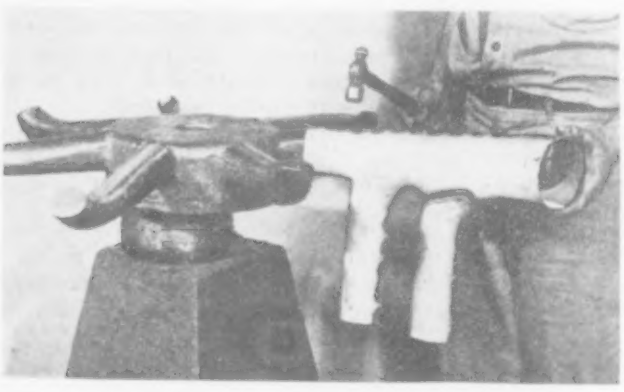

Fig. 6—Correcting Butt Edges by Hammering

port dimensions. Upon removal from this fixture, all necessary finish spot welding is done. The sections are sandblasted, passivated and rinsed in hot water. They are then checked on production inspection fixtures, minor dimensional adjustments made, and are then submitted to the inspection department for final approval.

While faulty technique in drawing, annealing or pickling may be serious, the faults in any of them are usually readily discernible, and can in most cases be detected by visual examination, or make themselves apparent as detriments to succeeding operations—faulty welding is not so kind, however.

Since the welding of stainless steel is a critical operation, the success or failure of the product is perhaps more dependent on individual skill and caution at this point than in any of the other stages of manufacture. For this reason all welders are carefully trained and closely supervised. New welders are under the direct supervision of an instructor for six weeks in the welding school and for approximately another three to five weeks on the job. Experienced welders, or those having had previous training, are carefully checked and instructed as necessary. All welders are certified by the Army Air Corps or Navy, prior to placement on the job.

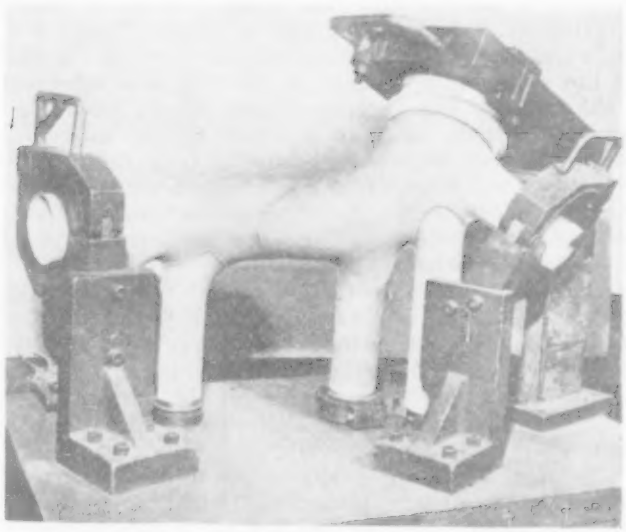

Fig. 7—Final Trim Fixture

As the greater part of the welding is done by the oxyacetylene process and thus the increased danger of getting defective welds not apparent upon visual examination, the cause and results of poor welding conditions are carefully explained and graphically illustrated to all concerned with the welding operations. This is supplemented by frequent checks and tests.

While it is not in our province to carry on extensive research in the metallurgical aspect of the welding of stainless steel, we have found it necessary to make investigations into certain phases due to the lack of available information, or to substantiate and demonstrate existing information. Results of two separate investigations, which may be of interest, are presented herewith. The first investigation was made to determine the susceptibility of welds to intergranular corrosion on certain combinations of columbium and titanium stabilized sheets welded with columbium, titanium and straight 18-8 rods. All welds were made with a very slightly carburizing flame, and flux applied to the underside of the weld. Each combination of sheet and weld rod was welded with and without flux applied to the rod. The results were as follows:

1. Titanium Sheet and Columbium Rod.—The microstructure of the weld consisted mainly of delta ferrite with negligible intergranular precipitation of carbide and no sign of intergranular corrosion after a 48-hr. Strauss test.

2. Titanium Sheet and Straight 18–8 Rod.—The microstructure showed only slight amounts of delta ferrite and slight intergranular corrosion. The weld without flux contained slightly more of both of these phases. Slight intergranular corrosion was noted after a 48-hr. Strauss test.

3. Columbium Sheet and Titanium Rod.—The weld made with fluxed rod had practically no delta ferrite while the one made without flux had small amounts. Both contained a slight intergranular precipitation of carbides. Slight intergranular corrosion was noted after a 48-hr. Strauss test.

4. Columbium Sheet and Columbium Rod.—These welds contained considerable amounts of delta ferrite with possibly a slight intergranular precipitation of carbides near shoulders of weld. The delta ferrite had a marked dendritic structure. After a 48-hr. Strauss test, no sign of intergranular corrosion was apparent.

The second investigation being presented resulted from difficulties experienced in welding of titanium bearing sheets with columbium bearing rods. A rather sluggish welding condition and a marked "pine tree" surface on the weld metal was noted in increased degrees as the columbium content of the rod was increased. Weld samples were prepared from sheets having approximately 0.60 titanium and rods having 1.3 columbium, and rods with only a trace of columbium. The welds were made with four flame conditions—oxidizing, neutral, slightly carburizing and carburizing, and with the weld rod both fluxed and unfluxed. In all cases, the underside of the weld was fluxed.

Examination of the welds revealed that the welds made with a trace of columbium in the weld rod, produced a steady weld, or had slight traces of "pine tree" appearance, while the welds with columbium rod had a definite "pine tree" appearance on the surface. The flame condition affected the "pine tree" appearance in the following manner.

The oxidizing flame produced the roughest, or most definite "pine tree" appearance, with the condition gradually minimized with the neutral, slightly carburizing and carburizing flames in the order mentioned.

The greatest columbium retention in the weld metal was attained with the oxidizing and neutral flames, while the lowest recovery was observed with the slightly carburizing and carburizing flames. The amount of columbium retained in the weld metal ran from 0.42 to 0.53%. The neutral flame and oxidizing flame both with and without columbium, contained less delta ferrite than the carburizing flames, even though the recovery of columbium in the welds was slightly greater in the former.

The welds were all similar in appearance, in that the region approaching the weld contained large grains, due to the welding temperature. At the shoulder of the weld, they all had a narrow strip of delta ferrite. The center of the weld was composed mainly of carbides of columbium, chromium and iron, a few nitrides and varying amounts of delta ferrite.

In addition to the specimens mentioned, specimens were prepared with columbium bearing rod, using a slightly carburizing flame applied at a 45° angle and a 15° angle, with reference to the plane of the weld. The 45° weld had the rough "pine tree" appearance, while the 15° weld produced a smoother weld, the "pine tree" appearance being considerably eliminated. The microstructure revealed that the 15° weld contained slightly less delta ferrite and the delta ferrite did not extend to the edge of the weld as it did in all other cases.

Conclusions as a result of the investigations were:

1. The "pine tree" appearance of the deposited weld metal is apparently the result of the formation of a two-phase structure of delta ferrite and austenite on solidification, and the consequent marked dendritic mode of solidification.

2. The presence of 0.40 to 0.55% columbium in the weld metal caused a considerable amount of delta ferrite to form on welding, thus the "pine tree" appearance.

3. The absence of any appreciable amount of columbium resulted in varying amounts of intergranular carbide precipitation occurring in the weld metal.

4. The use of flux on the filler rod both minimized the amount of delta ferrite formed, and the amount of intergranular carbide precipitation in the weld metal of the welds, particularly those not containing columbium.

5. The carburizing flames, as expected, produced the most intergranular carbide precipitation in the welds, with no columbium additions.

6. For practical consideration, it was observed that no particularly injurious results were apparent on any of the specimens, even after subjecting them to the most vigorous conditions of exposure.

It is believed that further investigation should be made to determine the maximum amount of columbium addition, as in one instance it was necessary to discontinue the use of a filler rod having 1.4% columbium content. Longitudinal cracks persisted in the weld metal when using this rod. Probably the weld metal was brittle at high temperature, however, no investigation has been possible up to the time of this writing. This and other considerations seem to us to indicate that a maximum columbium content should not be far from the amount required to balance the carbon content.

Arc and atomic hydrogen welding processes are being used by us to a considerable extent with very satisfactory results, especially on parts where severe forming is required after welding. No special problems have occurred with these processes, except the usual requirements of good joint preparation, and the careful training and supervision of operators.

In conclusion, it is appreciated that the information presented is for the most part, quite readily available in conjunction with many other fabricating and welding problems, however, a complete picture of our methods in the fabrication and welding of stainless steel has been presented in so far as it pertains to the manufacture of exhaust manifolds, and it is hoped that it may be of value to those confronted with similar problems.

We wish to express our appreciation to the American Steel and Wire Co. for the metallurgical examination and analysis of the test specimens mentioned in this paper.

The Measurement and Prevention of Eye Flash*

By Philip Drinker†

IT HAS been reported recently[1] that some 40% of the calls at shipyard dispensaries and first aid stations are for eye injuries. In new yards with inexperienced workers about half of these calls are for "eye flash." This is an unfortunate misnomer but a term which is free of all ambiguity—the doctor, the patient and everyone else knows precisely what is meant.

The burns which can and do occur occasionally from flashes are the result of a sudden heavy discharge of current through a fuse, circuit breaker or the like—a real flash, with the power almost of an explosion, vaporizes the copper conductors in a momentary blaze and those nearby may be severely burned.

Standards for Protective Glass

In arc welding nothing comparable occurs. It is well known that the electric arc, regardless of the electrodes used, is fairly rich in ultraviolet light. The cutting flame of the acetylene torch also gives off ultraviolet. Both the electric arc and the gas torch have such high intrinsic brilliancy that they should not be viewed without the aid of proper goggles or of special glass in the welding shield. The specifications for such glass have been developed and approved by the Bureau of Standards and adopted by the American Standards Association.[2] We have no criticism of these standards and no fault whatever to find with their use during welding, cutting, burning and even shrinking.

Most workers are cautioned not to look at the welding arcs and no welder would try to weld without his welding shield. Also he knows he can get a nasty burn, like sunburn, on his arms and neck if they are not covered. But when he flips up his welding shield to change rods, he is very apt to receive the ultraviolet rays from his neighbor's arc. If he is near enough and the exposure is long enough, he knows he will be burned, especially in his eyes. But it does not happen in a "flash"—it takes a surprisingly long time unless he is within a few feet of the arc.

Distance and Exposure for "Arc Flash" Injury

The question we have been asked repeatedly is: how near must one be to get an eye burn in a reasonable length of time? It was evident from the medical literature that no one had ever troubled to determine the precise relationship of time and distance which we needed to know in our shipyards.

The monograph by Verhoeff and Bell[3] describes in great detail the effects on the eye of various radiations. These authors showed that the biologic response varies inversely with the square of the distance from the source of radiation and directly with the time of exposure. They showed further that, within a 24-hr. period, the effects were cumulative. Their experiments were done with a mercury vapor lamp and a magnetite arc. So far as we know, no one had attempted to define in practical terms the time-distance relationship which applies to modern arc welding.

Drs. Kinsey and Cogan‡ performed with an electric arc-welding set a series of experiments[4] and determined the combination of distance and time necessary to produce minimal ocular lesions in rabbits, dogs and men.

Measuring Dosage by Light Meter

It was found that a simple way of measuring dosage was to measure illumination at the subject's eyes by means of a light meter such as is commonly used in photography. This meter is intended to be used with visible light, but it was found by comparing readings with those of an ultraviolet meter that the ratio of ultraviolet to visible did not vary significantly with changes in electrodes or with changes in operating current and voltage.

Therefore, if we find that a typical shipyard welding unit will just cause a perceptible eye flash in man, when viewed at 7 ft. for 20 sec., we know that at 56 ft. a comparable exposure will be $(56 \div 7)^2 \times 20$ sec. or 21.3 min. A number of us, without any protection, looked directly at welding arcs for 10 min. at 50 ft. without any burn resulting. Obviously we played safe as the dosage we used was less than half that of the computed threshold.

The welding expert will object that what we call dosage can be varied according to the way welding is done and again with the equipment, current, and voltage available. This criticism is just and to take such variations into account one should measure the intensity of illumination caused by the arc at the point where the possible eye flash is to be studied. In bright daylight, the light from the sun interferes with such measurements, but in the holds of ships, in shops, and at night there is no appreciable interference by extraneous light.

Workers Must Be Properly Protected

No one can say just how many minutes daily of unprotected exposure to welding arcs the average shipyard worker experiences. Arbitrarily we chose 10 min., but it might be argued that the figure should be more or less. At 50 ft., the average man will need over 20 min. exposure to show any real evidence of eye burns, and at 100 ft. he would need 80 min., assuming typical shipyard welding arcs.

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The ultraviolet screening effect of ordinary glass, including that in all types of eye glasses and safety goggles, is so good that eye flash virtually is nonexistent among workers who wear glasses. All shipyard men know that the yards cannot be lighted up like factories so that colored goggles may offer an annoying and sometimes serious risk of accident. We would welcome a more logical system of issuance of goggles; that is issue the colored antiflash goggles only where there is a definite need for them, such as to men constantly exposed to indirect radiations from electric arcs. Most shipyard workers would be adequately protected by hardened lens safety goggles with side shields

But all goggles to be worn near welding operations should be equipped with side guards for protection against foreign bodies. Eye flash from the side is a rare occurence, as is proved by the fact that burns of only one eye are virtually a medical curiosity. Theoretically they can occur, but practically they are extremely rare. However, welding is apt to cause some sputtering of tiny droplets; to avoid such droplets, goggles with side guards are essential.

In conclusion, we would like to point out that it was not our intention to investigate the diagnosis or treatment of eye flash. For that we would refer the reader to the paper by Dr. Rieke published originally in the *Journal of the American Medical Association* and given again before the Occupational Disease Session of this Congress.

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Repair and Maintenance of Tools*

By T. B. Jefferson†

THE subject of maintenance of tools and equipment by the use of welding, cutting, metalspraying and related welding processes, will only be discussed in its broader aspects. The application of welding for the repair and maintenance of tools and equipment is limited only by the ingenuity of those in charge of this phase of an industrial plant's activities. As we all know, welding has long been used as a means of repairing metallic parts made either of ferrous or nonferrous materials. For sometime these applications were quite limited but with increased metallurgical knowledge, better welding materials, new techniques and a more thorough understanding of the problems at hand there have been developed methods of tool welding. These tool welding applications have been used for the purpose of reclaiming worn and broken tools as well as for building composite tools to conserve strategic materials.

The war has placed increased emphasis on the importance, as well as the need for the maintenance of tools and equipment. War always presents problems but our present highly mechanized conflict has done everything possible to make these problems more complex.

Industry, after years of near stagnation because of the low purchasing power of the nation, was overnight turned into a producing agent which converted America into the arsenal of democracy. To expand our production facilities to meet these conditions necessitated the replacement and addition of many machine tools. As a consequence, machine tool production was greatly increased. Unfortunately, the sources of high-speed steel needed in the process of fabricating high-speed tools was not expanded as rapidly as plants or facilities for using tools. Industry could see the difficulties which lie ahead. Millions of dollars which were being spent for machine tools would be of no avail if cutting tools were not at hand.

The OPM and its successor WPB could not anticipate all of the expansion necessary to avoid what was to be a critical cutting tool situation. Neither could Washington foresee the action of our enemies which was to quickly cut off our supply of critical materials essential to the making of high-speed steels. The emergency, however, soon focused attention on the problem of conserving high-speed steels because of their relatively high percentage of strategic tungsten, chromium, vanadium and cobalt.

Changes in Tool Steel

High-speed steels containing 18% tungsten since have been replaced by molybdenum high-speed steels in which the tungsten content has been substantially reduced. Despite this important advance, much more remains to be done as the content of other strategic elements remains much the same and there are important demands for tungsten, chrome and cobalt for uses other than those of high-speed steels.

High-speed steels may be conserved through increased tool efficiency, by devoting proper attention to such factors as tool design, heat treatment, grinding procedure and cutting conditions. Experienced workmen have learned to change tool bits before they become too dull, to use guides to locate jig holes, to appreciate the importance of keeping spacing collars clean and parallel and, above all, the need of putting tools away carefully so as to make them last longer. However, there still remains the problem of waste due to the fact that only a small amount of the tool is actually used for cutting. To minimize this condition welding and brazing have been used for joining high-speed steel or cemented carbide tips to low-alloy steel shanks.

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When we look back to 1929 at a time when cemented carbides were selling for as much as $453 a pound, it is hard to believe that we would ever see the day when we would turn to cemented carbides as a means of conserving high-speed steel.

Nevertheless, considering the effectiveness of tungsten used in cemented carbide as compared to the tungsten used in high-speed steel, it has become advisable to use cemented carbides, even if only halfway suited, for such applications will make it possible to save high-speed steels for jobs where carbides will not do.

It is those jobs that must be done by high-speed steel that particularly concern us today. New employees unfamiliar with the operation of cutting tools frequently break or damage tools which in some instances cannot be replaced readily. If we were to wait for replacements of these tools, the delay in production might be from 6 to as much as 22 weeks. Such a delay cannot be tolerated in war production and it has become necessary to develop means of avoiding them. This is being accomplished by brazing and welding of worn and broken tools.

I shall highlight some of the means by which welding and brazing are being used to reclaim tools. While the examples selected by no means include all of the possibilities, they are representative of what is being accomplished in many shops and may present ideas which can be molded to suit a tool repair problem you may have at hand.

Whether the application is that of the repair or the fabrication of a tool the same general process may be used. Silver alloy brazing is probably the most generally used of the processes. This is particularly true with respect to tool reclamation and the application of cemented carbide tips. Another process much newer and rapidly gaining favor in the same field is low temperature welding.

Resistance butt welding is often used in the making of composite tools, especially those made by joining tool steels to mild steel shanks. The more commonly used processes for the repair and rebuilding of tools in the order of their popularity are: gas, arc and atomic hydrogen welding. Not many people are familiar with the advantages of using atomic hydrogen welding for this application or it undoubtedly would be much more popular.

Silver Brazing Applications

Silver brazing or as some prefer to call it, silver soldering, has been successfully used in reclaiming tools that would appear to be rightfully a part of the scrap heap. Such a tool was a tap which had shattered in ten pieces. The essentials required for any tool salvage operation are grinders, wire brushes, emery cloth, carbon tetrachloride, soft bristle brushes, fixtures and clamps for alignment, evenly surfaced steel plates for use in repairing slitting saws and flat milling cutters, etc. To this list must be added the brazing alloys with their proper fluxes and regular oxyacetylene welding equipment, including single and double flame torches and an assortment of various sized tips. The equipment needed to repair this tap consisted merely of an oxyacetylene torch, a short length of $^{1}/_{32}$-in. diameter silver alloy brazing wire, a jar of flux, a few ounces of carbon tetrachloride and a small length of Nichrome wire for holding the parts while brazing.

I might emphasize at this point that the first step in making a tool repair is that of properly cleaning the individual pieces irrespective of the welding process to be used. Care must be exercised to make certain that each part is scrupulously clean and bright. As a rule carbon tetrachloride is a most satisfactory agent for use in cleaning prior to welding.

Getting back to the tap, after cleaning, all of the surfaces were fluxed. It is important to use a flux which is completely liquid and active in dissolving oxides at the exact temperature required by brazing alloy. The parts of the tap are now assembled in a manner similar to that encountered in solving a Chinese puzzle. Upon completion of the puzzle, the assembled pieces were wrapped tightly with Nichrome wires making certain that all pieces fitted perfectly. In the wrapping process it is well to use several strands of wire inasmuch as it lessens the danger of the wire becoming loose when the tool is heated. Needless to say, pressure on the wire must be maintained throughout the brazing operation to insure a close fit between parts.

The actual brazing application is now begun by applying heat to the tap with an oxyacetylene torch. Furnace heating may also be used as a means of applying heat. However, the torch was preferred because of its speed in heating the steel and the convenience of control which prevents overheating.

Heat is applied until the flux becomes completely clear and liquid which indicates that the brazing temperature has been reached. The joints are then only touched with a silver alloy wire and because of the capillary attraction of the flux throughout the joint areas the alloy is fed to all surfaces. The alloy is thus fed until visible evidence indicates that all cracks have been completely filled. The final step in the repair of this tap was to air blast the assembly in order to cool it quickly to about 1000° F. This action is recommended in order to preserve the tool hardness. Tests have shown that very little if any hardness is sacrificed if the tool is heated quickly to a brazing temperature of approximately 1175° F. and brought back without delay to 1000° F. by air blasting.

A repair of this type is possible only with silver brazing or some similar alloy material which uses a capillary flux to flow the brazing alloy into all cracks and breaks.

Applying Carbide Tips

Silver alloy brazing is not generally considered in tool repair but is usually associated with tool tipping applications. The brazing of carbide tips to the cutting surface of a tool is a simple way to reclaim tools. This procedure of tipping high-speed tools may be followed not only for the purpose of reclaiming tools when they are worn out but actually before the tools are completely undersize. Even new tools in stock may be tipped when it is desirable to convert operations immediately to carbide-tipped tools for increased production.

The procedure for tipping tools irrespective of whether it is a single-point tool, for example a lathe tool, or a multiple-point tool like a milling cutter, requires that first we grind back the faces to which the tips are to be brazed. Naturally the depths to which these faces are ground depend upon the thickness of the tip to be used.

During brazing of multiple tip tools the tips should be placed so that they line up. It is not always necessary to grind a recess for the tip, the latter may be brazed to a flat surface since tool loads are rarely so great as to demand support around the tip. Often, a milled longitudinal groove is sufficient if the high-speed tool is first annealed.

The major difference between tipping a carbon steel shank and a high-speed steel shank with carbide is that greater care has to be taken to prevent oxidation. When

you heat high-speed steel there is a tendency for the chromium in the steel to sweat out. If the chrome is allowed to oxidize, it forms a surface to which it is difficult to make a braze adhere since standard brazing compound will not wet chrome oxide properly.

This factor may be overcome without difficulty. The main things to observe are that the shank should be heated carefully, not more than necessary, and that plenty of flux be used to keep the chrome from oxidizing. It will also help to move the tip with a rod if possible when the shank is heated to help wet the steel surface with the brazing alloy.

When the tip is brazed to the shank it should be allowed to project slightly over the edge of the steel. After all the tips are brazed in place, the completed tool should then be ground to the proper diameter or size.

As the tool wears down in service, it is an easy matter to bring it back to size. It is merely necessary to apply heat to the tool loosening the braze, move the tips out slightly and allow the braze to set again. The tool is then reground to the proper size. This procedure can usually be repeated several times during the life of a tool and the tips can be replaced with new tips when necessary.

Silver Brazing Procedure

While the preferable method of brazing tips to steel shanks is to heat the shank rather than the tip, it is necessary sometimes to heat through the tip to keep perfectly brazed adjacent tips from becoming loose. When this is done, care should be taken to heat the entire tip evenly to prevent cracking during the expansion of the carbide.

We are, of course, anxious to preserve the hardness of the high-speed steel, which has probably been quenched from a high temperature and then drawn at approximately 1050° F. to a hardness of about 65 Rockwell C. Fortunately, it is possible to reheat tool steel so treated up to 1200° F. without lowering their Rockwell C hardnesses more than 2 to 5 points, provided the time while the steel is kept at 1200° F. is very short.

The brazing procedure is as follows:

First, clean the joint surfaces of both tip and shank by either chemical or mechanical means. Be sure all joint surfaces are close fitting.

Second, coat all joint surfaces liberally with a brazing flux.

Third, apply the brazing alloy. Thin sheet inserts may be used. The preferred practice, however, is to apply the alloy by tinning all recessed surfaces of the carbon steel shank with wire. This is done by heating the underside of the shank to a temperature of about 1200° F. with an oxyacetylene torch and allowing the wire to flow on the recessed shank surfaces.

Fourth, the fluxed tip is placed into position while the shank is hot. Since the cold tip will naturally chill and solidify the brazing alloy, the torch is again brought into play. The torch flame should be directed to the underside of the shank so that the heat will soak through the shank and heat the steel tip by conductivity. This heating method will prevent overheating of the tip. The proper brazing temperature is reached when the tool tip will slide around easily on the film of molten alloy.

Fifth, allow the alloy to solidify, holding the tip in place while applying a light pressure by means of tongs or a steel rod.

Sixth, shorten the period in the softening range by cooling to below the critical temperature of 1050° F. as rapidly as possible. This may be accomplished by using an air blast or an oil quench.

Brazing Temperature Is Critical

The necessity for a closer temperature control than in most brazing operations is the essential feature in successful brazing of high-speed steel tips. Too low a temperature may make a poor bond, while too high a temperature may substantially lower the tip hardness. Furnace heating is therefore unsuitable, inasmuch as in the furnace the heating time in the softening range of the steel would, in general, be too long.

Oftentimes it is desirable to tip high-speed tools and at the same time harden the tool. Following the rough machining the portion to be tipped is ground. The high-speed tool tip is also ground to meet the exact contour of the blank. This is to assure a definite overall contact. After the parts have been thoroughly cleaned they are assembled. Next there should be inserted between the tip and the shank a 0.005-in. copper shim and the assembly held together with a piece of Nichrome wire. When both tip and shank are covered with a suitable flux the tool is ready for brazing and hardening.

The brazing and hardening operations are done at and from the same temperature. The tool is put in a furnace for the preheating and kept in the furnace to bring it up to a temperature of 2375° F. If the tip is made of molybdenum steel 2250° F. is sufficient. The tool is now removed from the furnace in such a manner as not to disturb the tip. The tip is held firmly in place while the excess copper and flux are squeezed out. It is quenched in oil until it turns black (approximately 1000° F.) and then cooled in still air. The tool is now tempered at 1000 to 1050° F. and air cooled. It may be retempered at this temperature and cooled again after which it is finished ground. Tool repair is not confined to these brazing operations, however, as welding by arc, gas and atomic hydrogen processes have come in for their share.

Atomic Hydrogen Applications

Before the war the Germans made extensive use of atomic hydrogen welding as a means of tool repair and as a result of their work, considerable experimenting has been carried on with this process in this country. Atomic hydrogen welding is one of the newest fusion welding processes. It combines the advantages of easy regulation and accurate control of penetration with the inexpensive heating characteristic of arc welding. In addition there are two particularly valuable properties. These are: the reducing properties of the hydrogen flame in the welding zone and an extremely high rate

Fig. 1 (Above)—Broken Milling Cutters. (Below) The Same Cutters After Having Been Repaired by Atomic Hydrogen Welding and Reground

of heat transfer or surface heat available from the atomic hydrogen flame.

The widest application of atomic hydrogen welding is found in making surface welds such as those used in building up worn dies, molds and similar tools used in the rubber and plastic industries. Here the extremely high surface heat is valuable in that a quick weld may be obtained with a minimum of distortion while the reducing envelope of the atomic hydrogen gas prevents oxidation of the welding surface. This condition provides a solid, dense deposit of weld metal which is extremely important for this type of work. Another advantage afforded by the use of atomic hydrogen welding is the fact that filler metal frequently may be obtained from scraps of base metal or possibly cut from the work piece itself. This is a particularly attractive feature of the process in that practically any of the commonly used base metals can be welded. On the other hand, because of the ease of obtaining filler metal it is ideal for the repair of special alloys such as chrome, nickel and molybdenum steels as well as nonferrous materials. When it is necessary to obtain filler rod by cutting it from a piece of bar or a die it is best to use a band saw. Care should be taken to obtain clean metal, that is, avoiding the outside of the bar. This prevents any decarburized surface steel from getting into the weld.

The most common breaks experienced in cutting tools are those in the cutting edge. Consequently, the repair of such a break is possible only by a fusion welding process. In Fig. 1 there are shown several milling cutters before (above) and after repair and machining (below). Naturally, in the repair of such high-speed tools if they are to be welded their alloy components must be completely protected against harmful absorption of oxygen. Their composition after welding must remain the same if their original high-cutting ability is not to be diminished. For this reason it is desirable to use a filler rod having the same composition as the base metal.

The recommended procedure for repairing these cutters would be to anneal them prior to welding to prevent further breakage as a result of stresses incurred by a concentration of welding heat. Annealing may be accomplished by heating to approximately 1300° F. The welding operation was then carried on while the cutter was held at a red heat. After the welding the cutters should be stress relieved again at temperatures of approximately 1300° F. to eliminate any stresses that might be set up at the point of welding. The method of annealing is immaterial. The cutter may be annealed directly in a furnace or in a carburizing bath.

Irrespective of the method of annealing used, in all cases the welded parts should be cooled slowly, and evenly, so that new stresses will not be created by irregular cooling. It is also imperative that the cooled parts remain in a machinable condition so that a new cutting edge can be established.

When the part has been cooled completely the welded portion in then ground or if necessary the entire tool is refinished. Refinishing is usually always necessary when the tool has been warped during welding inasmuch as warpage cannot be entirely eliminated by straightening. This particularly refers to broaches which have been repaired.

After having refinished the cutters they should be hardened just as if they were new unwelded tools. Since the high-alloy steels tend to surface decarburize at high temperatures it is important that the hardening process be carried out in a decarburizing furnace or salt bath. A certain addition of carbon may be desirable in order to compensate for a possible loss of carbon during heating. Actual tests indicate that cutters repaired in this manner and subjected to proper heat treatment are equivalent to new cutters as far as cutting characteristics are concerned.

If not properly heat treated, tools of high-speed steel which have been repaired by atomic hydrogen welding will have reduced strength. Favorable results, however, have been obtained where tools were not operated to capacity and therefore the reduced strength of the repaired tool did not show up. This application, however, is highly satisfactory where the tools are made from materials other than high-speed steels.

Reclaiming High-Speed Drills

Drills, especially the high-speed variety have become extremely critical because of the abnormal demand for drills, coupled with the drill manufacturer's problem of obtaining the necessary material, machines and skilled labor to produce them. It is expedient, therefore, to conserve carefully any stock of drills you may have on hand and to treat them with the greatest of care. Some users have instituted programs of reclaiming drills which have resulted in the salvaging of thousands of dollars worth of drills at a cost of from 5 to 10% of their regular purchase price.

In general, there are two types of breakage to twist drills. The most common is the broken or twisted tang. The tang of a drill which fits into the socket of the drill press spinnel transmits the spinnel drive torque of the drill. Because of this it receives severe punishment and under severe conditions of improper fitting, excessive feeds, excessive spinnel speeds or improperly ground cutting bit, the tang may be twisted or broken off and the drill rendered unusable.

Preparation of the drill for a tang repair is quite simple. The first step is that of removing the damaged portion if the tang is twisted, or if the tang is broken off no particular preparation is necessary other than to grind the rough surface of the break slightly. The drill is now clamped in an upright position, and the tang end built up. The preferred practice is with the oxy-acetylene torch. The torch tip size is governed by the cross section of the tang. It should, however, be held to a minimum. The puddle of the molten metal should be carefully controlled to avoid blowholes. This may be perhaps best contolled by using the minimum flame and withdrawing it slightly at the end of each pass. After the weld is completed, the welding zone should be reheated to a dull red and then buried in asbestos wool, lime or some other insulating material and permitted to cool slowly.

The second type of break encountered in drilling operations is less common than the one just mentioned. In this one, the drill is broken in two, either at the point where the shank meets the fluted portion or in the flutes themselves. Such a break is usually caused by carelessness on the part of the drill press operator because of an improperly ground bit. Breakage of this type is increasing because of present-day high-speed production and a necessary higher percentage of inexperienced operators in machine shops.

A broken shank requires a little more preparation than the twisted tang. The repair of this type of break consists of substituting a new shank for the old one and brazing it in place using a bronze welding rod. This repair is quite similar to that which would be undertaken in repairing a broken shaft, that is, the parts are lined up on vee blocks and welded together. After the brazing operation has been completed, the part should be reheated to a dull red or a little less, then placed in an annealing bin to cool slowly. After the drill has cooled, it is chucked in a lathe and a standard taper is turned

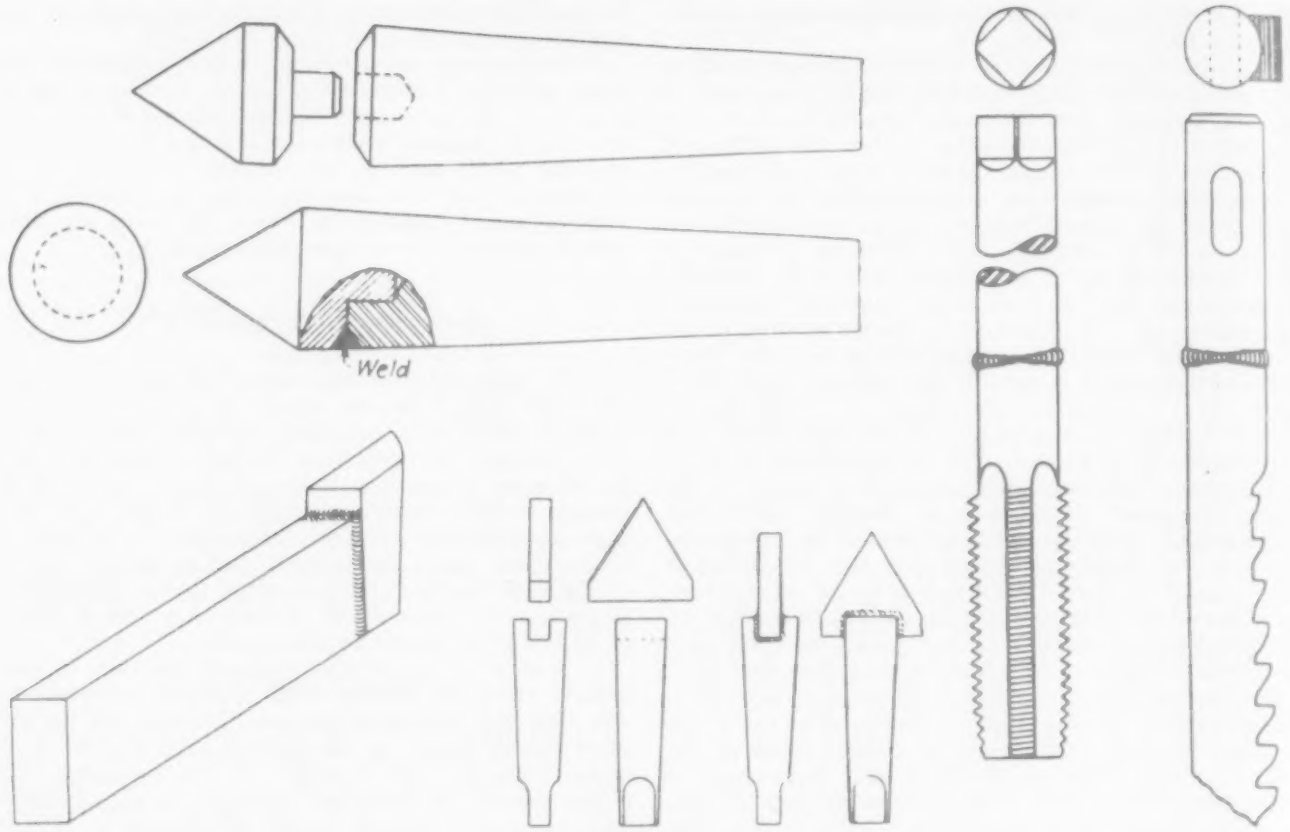

Fig. 2

on the shank after which it is placed in a milling machine where the tang is cut on the new shank.

Should the drill be broken in the flute, surprising as it may seem, very efficient repairs can be made by using silver brazing. For example, a drill approximately 23 in. long by $3\frac{5}{8}$ in. in diameter is made of high-speed tool steel. This drill broke in two while drilling holes in the cast steel base of a hydraulic press. Its repair was accomplished by carefully grinding the broken ends to flat surfaces after which they were carefully aligned fluxed and jigged into position. Several torches were used simultaneously in order to heat the drill rapidly and evenly to a brazing temperature of 1175° F.

Silver alloy wire was fed into the butt joint and was pulled by capillary attraction through the closely fitted joint area. The success of this repair is evidenced by the fact that this drill has been successfully returned to service.

Lathe Tools Repaired

Lathe centers may be rebuilt by welding. After the deposition of a hard-facing material having a high red hardness characteristic, the center is finished by grinding. If it is desired, however, welding may be used to build a composite lathe center.

Figure 2 shows several examples of the tools which have been fabricated by a Columbus, Ohio, equipment manufacturer. These composite tools were fabricated by welding high-speed pieces to carbon steel.

In the upper left-hand portion is pictured a composite lathe center which is made up of high-speed steel point welded to the shank of a carbon steel center. It was necessary to make such a lathe center because increased production demanding greater feeds and speeds, made the carbon tool steel center unsatisfactory. Even when high-speed centers have become too short for use, they may be reclaimed by annealing and welding on a new center as illustrated. In this operation it is extremely important to anneal the piece after welding to completely relieve stresses.

In the lower left there is shown a roughening tool for lathe, shaper or planer. Several other designs have been used to conserve high-speed steels, but the design shown has worked out to be one of the most practical. These high-speed steel points can be forged in a swage, annealed and then cut into the desired length by a power hack saw. Old tools which have become too short for further service can be forged to meet these requirements. After the welding has been completed they are heated and ground to shape while hot. It is considered good practice to give all welded and forged tools a good annealing after these operations. In building a composite tool of this type, instead of forming one of $\frac{3}{4}$ in. by $1\frac{1}{2}$-in. steel, it is possible to save approximately $3.72 per tool.

In the lower center is pictured a countersink which was made by using the shank of an old drill. The sketch amply indicated the procedure to follow. This item really illustrates the possible savings that may be accomplished using composite tools. The cost of the high-speed steel in this plate was less than $1.00. However, had the countersink been made completely of high-speed steel, it would have required more than $6.00 worth of material in addition to forging and machining costs which would have made the cost three times as high as the cost of the steel. Instead, as shown, material and labor do not exceed $3.00.

There is also shown the method used in welding an extension on a tap. The stock used can be either drill rod or low-carbon machine steel. The only precaution necessary in welding such an extension is to make sure that small globules of hot metal are not deposited on the threads.

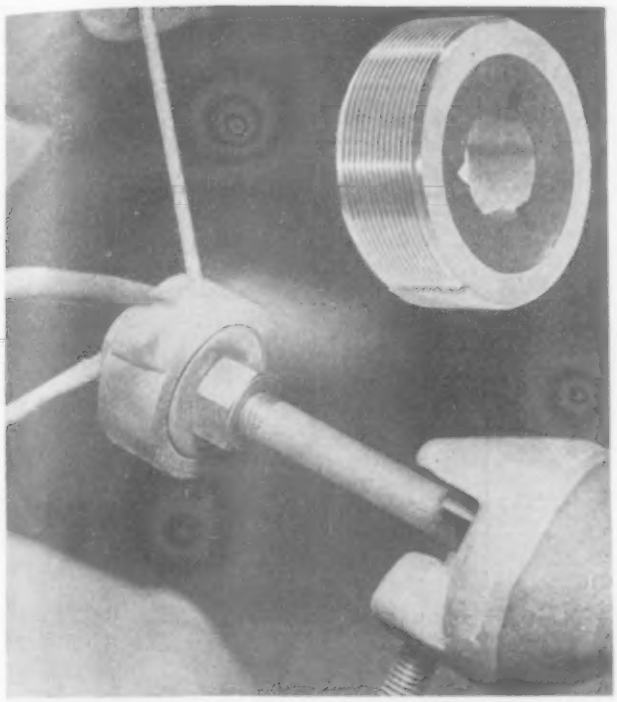

Fig. 3—Thread Gages, Made of Ordinary Steel and Hard Faced Instead of High-Speed Steel. Insert Shows a Finished Gage After Hard Facing and Grinding

Welding High-Speed Broaches

At the extreme right is shown a high-speed steel broach which had a broken eye. About 4 in. in back of the eye the broach was cut by grinding. The temper was drawn at the stub and ground to a point. A piece of $^{3}/_{4}$-in. drill rod was ground to a point and welded to the broach as shown. When the machine work was finished, the point was tempered. It is conceded that carbon tool steel properly tempered will withstand greater pulling stresses than high-speed steel. Hence, the broach was stronger in the eye than when new.

Some who have tried to make composite tools in the manner described have experienced failure. It is believed that this difficulty is because of apparent brittleness due to the formation of new carbides as the result of the high temperature of the weld. Since the best results are obtained by not heating high-speed steels above 2350° F., they should be taken in on all welding applications which involve this method. Above this temperature grain growth develops rapidly.

It is also a difficult operation to machine composite tools after welding but if the tools are heated to 1500° F., quenched and then annealed according to standard practice for high-speed steels, no difficulty will be experienced. Also, it has been noted that if this treatment is applied to tools with thin sections, a gain of strength and less breakage will be experienced.

The repairing of broaches is probably one of the most difficult of tool repair jobs to be undertaken. More difficult than the welding work itself is the straightening of the part after welding has been completed. In the repair of broaches it is absolutely necessary that the accuracy of their original dimensions be maintained if the broaches are to retain their useful value.

Broach repairs are not limited because of size. Frequently repairs are made of high-speed steel broaches for broaching holes in steel as small as $^{3}/_{16}$ in. square. In the welded repair of such small broaches $^{1}/_{8}$-in. diameter straight carbon steel drill rod is often used as a welding rod. If proper care is taken it is frequently possible to complete these repairs without the necessity of rehardening.

A number of large broaches were repaired by brazing. Each was approximately 5 ft. long and over 2 in. in diameter. Prior to brazing, each broach was carefully lined up in a jig and torch heated. The brazing alloy completely wetted the joint area and made a high-strength bond. Service records of repaired broaches indicate perfect performance throughout the normal life of the tool.

The success with which these repairs are made can best be illustrated by relating an incident which recently occurred in the plant of a broach manufacturer. A customer had returned a broach to be resharpened and the grinder noted that several teeth in the center of the broach seemed to be somewhat softer (3 or 4 points Rockwell C) than the other teeth. Since this was an unusual condition; he reported it to the management, who, in turn, inquired of the customer if he knew of any reason why the teeth in question should be soft. The answer was that the broach had been broken and repaired by brazing. The broach manufacturer was quite surprised as he did not realize his product could be repaired—especially repaired in such a manner that those employed in making broaches could not detect it.

Figure 3, pictures the manner in which a thread-gaging tool is fabricated by the use of cold-rolled steel and hard facing. The periphery of this tool is coated with a $^{3}/_{16}$-in. deposit of hard facing. In making this application, the cold-rolled steel is ground to remove all oxides and preheated prior to the deposition. After welding has been completed, the tool should be pack annealed for several hours. As soon as it has cooled sufficiently to be handled in the bare hand, the threads may be ground. Inset is the completed gage. Before using this method of building these thread gages a tool steel gage lasted on the average of 4 hr. At the last report the gage pictured had been in service for more than 60 days and is still going strong.

The same conditions which have made our tool problem serious may be applied to much of our industrial equipment. Lean years reduced maintenance to an absolute minimum with only the needed repair being undertaken. Then with the war boom, repair parts became difficult or impossible to obtain because of priorities, shortages and the like. So in this field it was likewise necessary to resort to welding and brazing as a means of maintaining equipment.

Welding of Railroad Transport Equipment*

By Charles O. Druetzler†

IT HAS been said wars have a way of ending old eras and starting new ones. Following the peace of 1863 the nation was first united from coast to coast by bands of steel (May 10, 1865), thus opening up a new frontier for the work we, in the business of building railroad equipment, are now carrying on into broader, better, constantly more efficient and rapid horizons. Geographically America has no frontiers, technically we have many. Already the curtain has been drawn back on one element of the new era that will remain long after the present conflict is over; the utilization of arc-welded design and construction in railroad transport equipment.

Since considerable information has already been given on the general over-all construction, capacities, superiority, power, performance and efficiency derived from this type of railroad transportation equipment, this paper contains a brief description of the construction and procedures used in arc welding the General Motors Diesel Electric freight locomotives that are built by their Electro-Motive Division in La Grange, Ill.

The underframe, a structure of about 25,700 lb., is built today contrary to conventional methods of building locomotive underframes. We, in the Diesel Electric locomotive business, have found it advantageous to build them bottom side up. At proper intervals the underframe is placed in a 45° and 90° angle to keep vertical and overhead welding at a minimum. Major parts and design features are illustrated in Fig. 1.

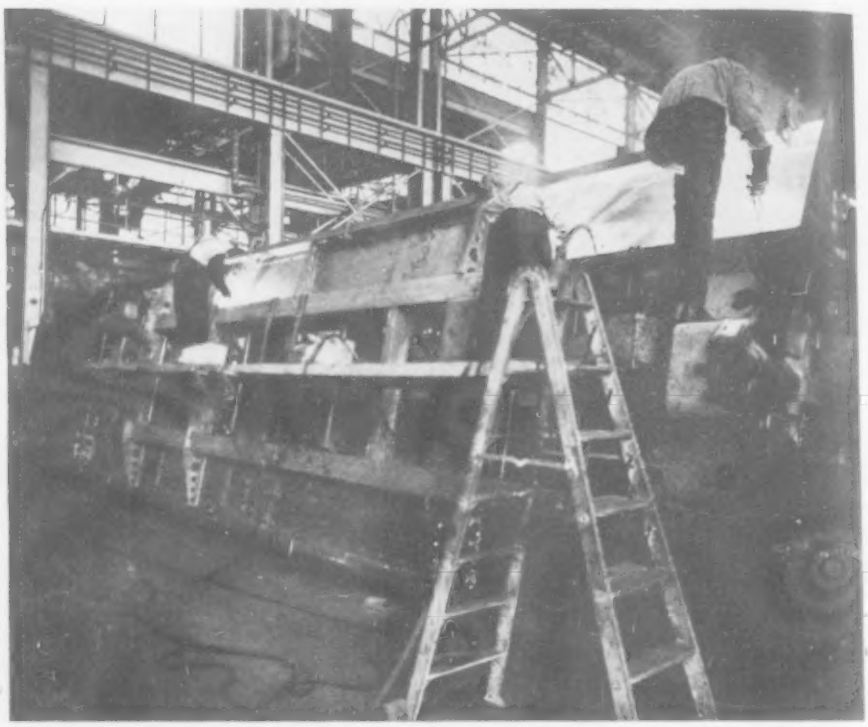

Fig. 2—Positioning to Facilitate Down-Hand Welding on Underframe

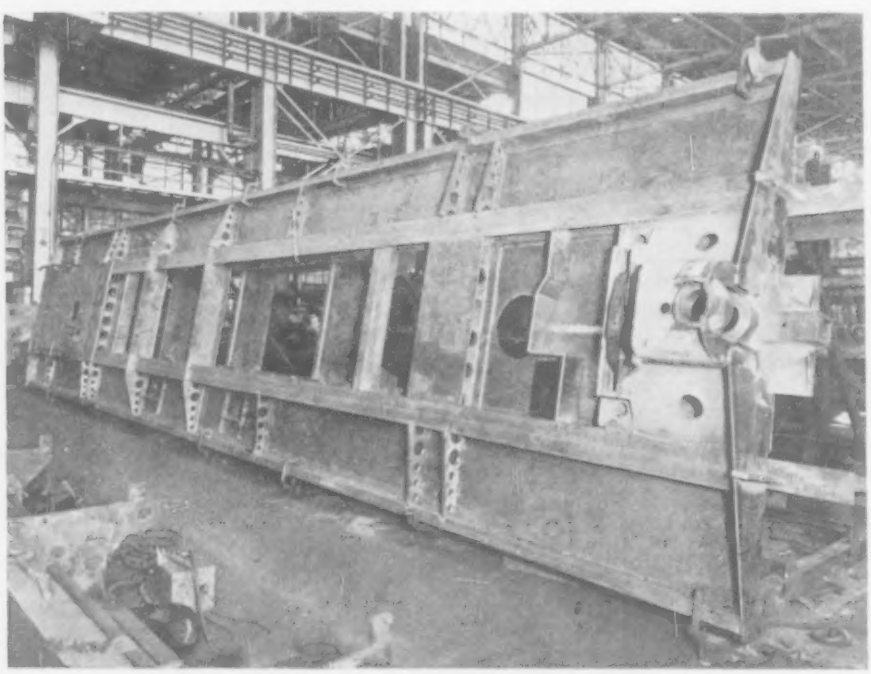

Fig. 1—Underframe of Diesel Electric Locomotive

Fig. 3—End and Front View of Water and Lubricating Oil Cooling Tank

Several subassemblies compose the finished underframe. The center section, which carries the major load, consists of the following items: (*a*) center sills, (*b*) bolsters and (*c*) cross bearers, all of which are assembled in suitable jigs. (*a*) The

* Presented before Annual Meeting, A.W.S., Chicago, Ill., Oct. 18 to 21, 1943.

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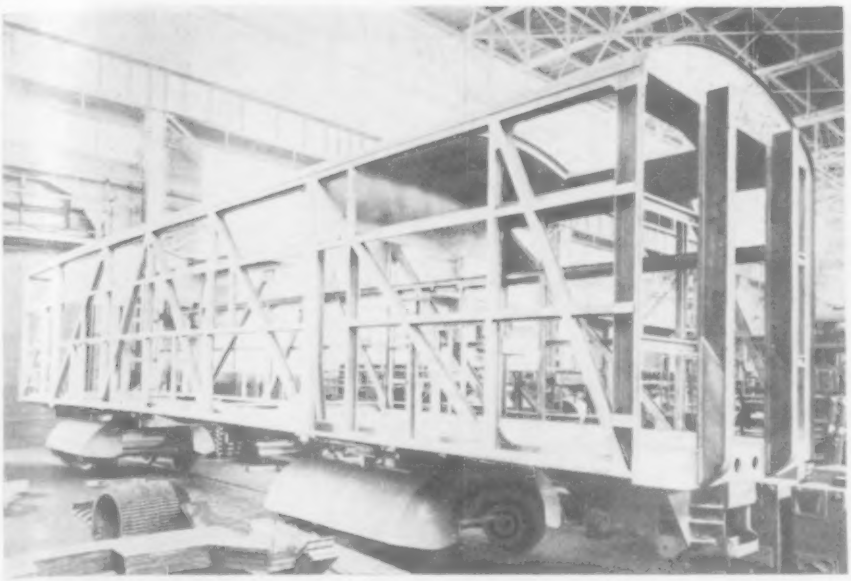


Fig. 4—Side Frames Follow Principle Governing Modern Bridge Construction

Fig. 5—Typical Side Frame Joint

center sills, which are 8 in. at 31-lb. H beams 46 ft. 6 in. long for "A" sections and 45 ft. 8 in. for "B" sections, are of high-tensile, low-alloy welding quality steel and are prepared by welding 1/4-in. and 3/8-in. diamond reinforcing plates in place for the subsequent fitting of bolster and cross bearers, thereby eliminating transverse welding. (*b*) The bolster is constructed of 1/2-in. top and bottom plates and 1-in. web plates. More rigidity is obtained by connecting the web plates to five 5-in. extra heavy pipes through which air passes for cooling the powerful traction motors that are mounted on the trucks. Flame-cut openings were made in the web plates for these pipes. After being fitted and tack welded together the bolster is placed on a positioner where all welding is completed in a downhand position. Material used is of low-carbon welding quality steel. Welds used are 1/2-in. fillets on the bolster and 3/8-in. fillets around the pipes. (*c*) The cross bearers, also a sub-assembly, are made from 3/8-in. low-carbon steel and welds are 5/16-in. fillets.

Upon completion of welding the center section is placed on a 1/4-in. floor plate which is an assembly of six pieces. The four end pieces, which are part of the front and rear platforms, are of high-tensile, low-alloy steel, while the two side pieces are of low-carbon steel. Suitable openings on the floor plate are provided for Diesel engine, generator, electrical equipment, etc.

Standard side sill zee sections 5 x 3 1/4 x 3 1/4 x 5/16 in. to which 1/4-in. diamond plates have been welded for the fitting of 1-in. outer bolster sections and 1/2-in. outer cross bearer sections are welded to the floor plate. At this time other sub-assemblies, such as fuel tank hangers, air and electrical cable ducts, generator pan, air compressor support, front and rear platforms with coupler pockets (platforms and coupler pockets being previously assembled) and other necessary supports are fitted and tack welded in place. Front and rear platform bottom plates, to which grade "B" annealed cast coupler pockets are welded with 1-in. fillet welds, are of 3/4-in. high-tensile, low-alloy steel adding to the strength of the structure. At the completion of fitting and tacking of sub-assemblies the underframe is placed in previously mentioned position, as shown in Fig. 2, where welding of the underframe structure is completed. At this stage all underframe wiring, piping and clamping of same are performed.

Table 1—High-Tensile Chemical Composition, % Low-Alloy Welding Quality

Carbon	0.15 max.
Manganese	0.50–1.00
Phosphorus	0.40 max.
Sulphur	0.05 max.
Silicon	0.05–0.05
Chromium aim	0.40 max.
Nickel	0.25–0.75
Copper	0.50–0.70

Chemical composition of the high-tensile, low-alloy welding quality steel used in our locomotive construction is described in Table 1.

The underframe is then placed in the deck position, top side up, where the Diesel engine, weighing about 30,500 lb., generator, about 12,950 lb., air compressor, air reservoir, water and lubricating oil tanks, and other underframe equipment are installed. Necessary brackets

Table 2—Electrode Data for E6012 Classification

Diam. of electrode, in.	3/32	5/16	1/4
Length of electrode, in.	14	14	14
Normal current intensity, amp.	150	180	250
Voltage	22	24	26

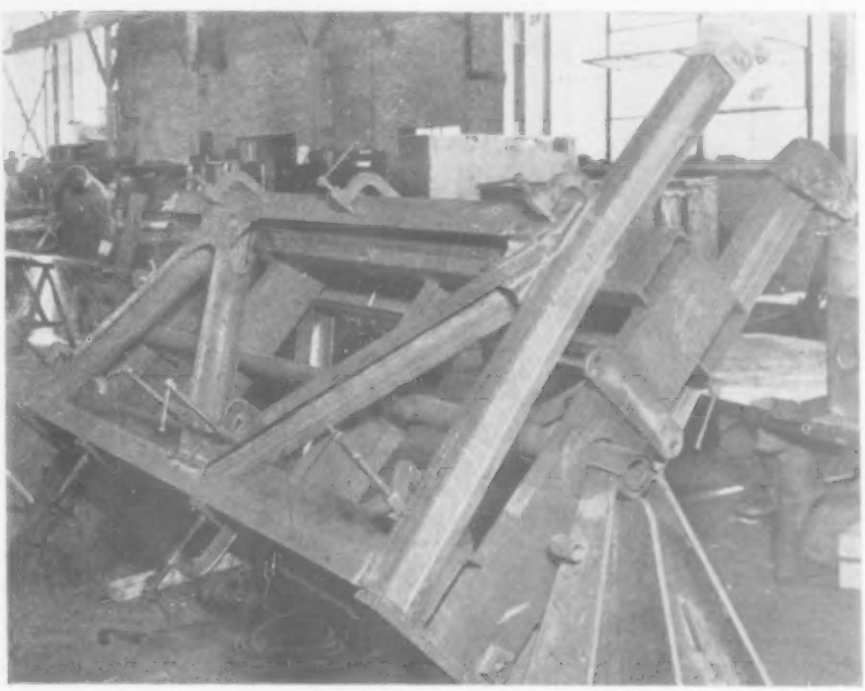


Fig. 6—Front End Side Framing in Welding Jig

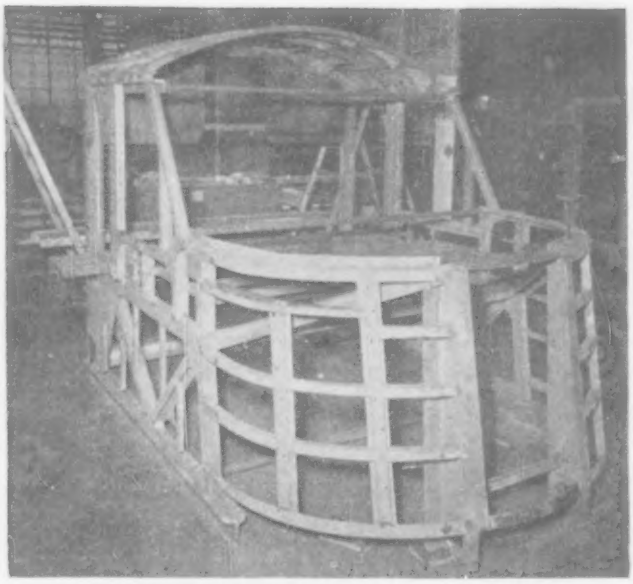


Fig. 7—Front End and Side Framing in Assembly Jig

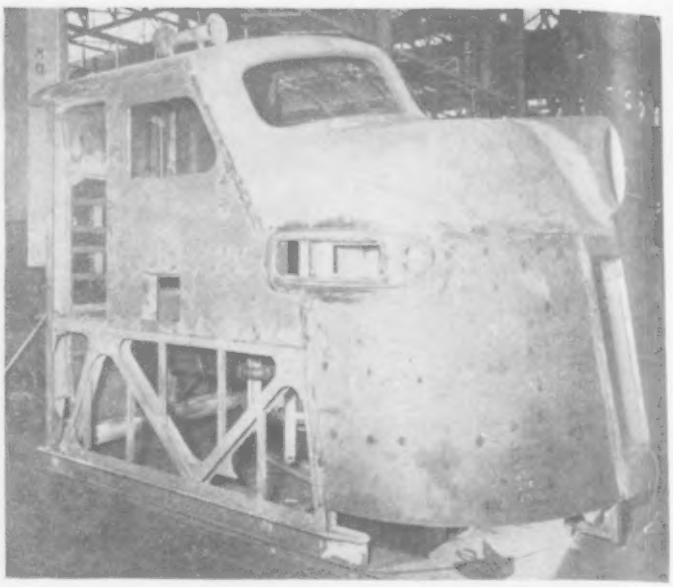


Fig. 8—Hood Framing and Outer Sheeting on Welding Jig

and clamps are then welded in place. One of the subassemblies—a water and lubricating oil cooling tank—is made of 10-gage and 1/4-in. material and welded with 5/32 and 3/16 electrodes with straight polarity (Electrode Negative). This assembly accomplishes what formerly required the use of three tanks. Figure 3 shows the rear and end view of such a tank. Size of the tank can be judged by comparison of welder at the lubricating filter container. Electrodes used in this assembly and other low-carbon steel items in the locomotive construction are in the A.W.S. E6012 classification. Electrode data are given in Table 2.

Being based on the principle governing modern bridge construction, side frames (Fig. 4) are naturally of right- and left-hand design, and consist of: (1) the load-carrying bolster posts of 6 in. at 20-lb. H beams for front and rear posts on "B" sections and rear posts on "A" sections; (2) 6x3-in.15.1lb.channel for front posts of "A" section. Channels are beveled and welded together at the marriage of the front end and car body. Important diagonal and horizontal members of 4 in. at 13.8 lb. H beams are of high-tensile, low-alloy welding quality steel. Other intermediate members of special pressings to support pipes and other pieces of equipment are of low-carbon quality steel. In order to standardize all welding procedures, the various joints on the car body have a 60° included angle to insure complete penetration before gussets of 7-gage material are fitted. The gussets also have a 30° bevel on the inner edge to eliminate the possibility of bridging root of joint when the gusset is welded to side frame members. Typical side frame joint is shown in Fig. 5. All joints are ground smooth for subsequent placing of side paneling. Electrodes used in welding all the high-tensile, low-alloy material are in the A.W.S. E7010 classification with reverse polarity (Electrode Positive). Electrode data are shown in Table 3. At present the side framing is constructed on a vertical jig, but in the near future it will be replaced by a movable jig, thereby eliminating vertical and overhead welding altogether.

Table 3—Electrode Data for E7010 Classification

Diam. of electrode, in. ..	5/32	3/16	1/4
Length of electrode, in...	14	14	14
Normal current intensity, amp.....	140	170	240
Voltage.....	22	24	26

The roof framing is made up of side plate angles of standard shapes and car lines of special pressings to which the 11-gage roof sheet is plug welded from the inside of framing. To obtain a smooth, streamlined finish continuous butt welds are made at joints and ground down. All welds are being made with low-carbon electrodes of the E6012 series. Rectangular openings in the roof are for the removal and replacement of all large equipment, such as Diesel engine, generator, air compressor, oil and water tanks, etc. These openings are covered by bolting roof hatches, another welded assembly, to the roof.

The massive front end framing of the freight locomotive resembles the present popular high-speed Diesel Electric passenger locomotive. This structure also is made up of subassemblies, *a*, *b*, *c* and *d*.

(*a*) Side section is comprised of 4 in. at 10.5-lb. I beams of high-tensile steel,

Fig. 9

Fig. 10

Fig. 9—Outer View of Damaged Front Framing in Head-on Collision
Fig. 10—Inner View Front Framing Left Side. Welds Did Not Fail

Fig. 11

Fig. 12

Fig. 11—Outer View of Front Side Framing Right Side, Beams and Gussets Torn and Broken
Fig. 12—Inner View Front Framing, Left Side

while other members are of low-carbon steel (Fig. 6).

(*b*) Figure 7 illustrates front section, with pressed $^3/_8$-in. diagonals and 7-gage stiffening angles and channels to which the outside 12-gage sheeting is plug welded. Collision posts of 5 × $1^1/_2$ in. cross section, which carry the major impact, are of high-tensile steel welded by the Unionmelt process with $^1/_2$-in. fillets.

(*c*) The hood framing is made with a 5.7-lb. x 3-in. x $2^3/_8$-in. center I beam; standard 2 x 2 x $^3/_{16}$-in. angles formed into carlines, to which the carefully hammered 12-gage hood sheet of 14 pieces is plug and tack welded.

(*d*) Figure 8 pictures the hood and front sheeting in place. Lower side sheet is omitted for the present to facilitate front section welding to underframe.

Having the safety of the operating personnel uppermost in mind, the engineers who drew up its plans made this framing of very sturdy design. It is worthy of note that for all the present Diesel Electric locomotives in operation in this country, totaling more than 100 million miles, no lives have been lost because of failure of this design and construction. A few casualties have been caused by other factors involved in accident.

The following close-up views show that this type of construction is reliable, although the parent material may fail.

Figure 9 shows outside view of damaged front framing.

Figure 10 is inside view of same joint showing that beams and gussets have been torn and broken but welds have not failed.

Figure 11 shows outside view of front side framing on opposite side.

Figure 12 is inside view of same joint.

Figure 13 is an upper end view of the

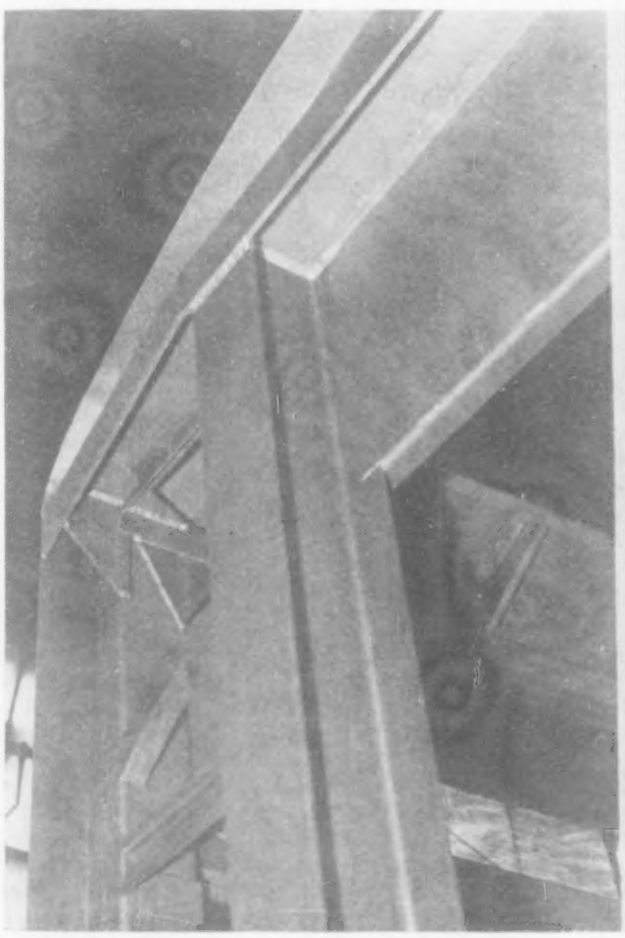


Fig. 13—Upper End View of Rear Framing

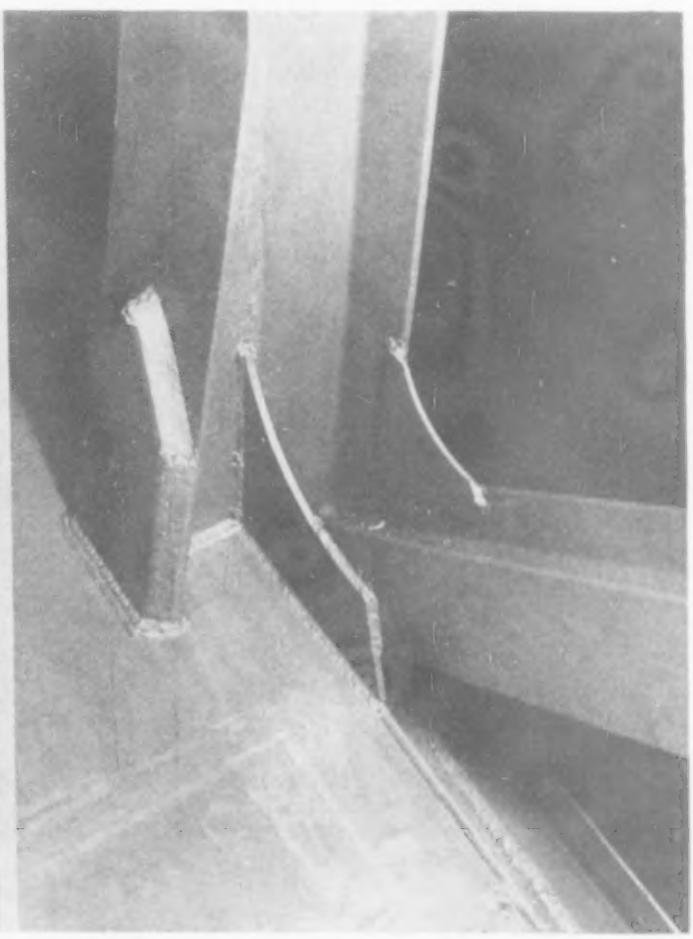


Fig. 14—Side Frame Application to Underframe at Bolster

rear framing which is also a subassembly having a 13-in. wide and $^3/_8$-in. thick antitelescoping plate which is strengthened by a 2 x 2$^1/_4$-in. angle and welded securely at both ends to side framing. The rear collision post is of high-tensile steel.

In contrast to former methods of car body construction, that is, building the car body complete, then installing the equipment, we use the subassembly method and install the equipment at the completion of subassembly work. After finishing side, roof and end frames these subassemblies are fitted and welded together forming a car body. Then all possible equipment is installed. The same holds true of the front end. Upon marriage of front end to side and roof framing, completing the car body construction, it is placed on the underframe. Typical side frame application to underframe is shown in Fig. 14. When welding of car body to underframe work has been finished the outside paneling is applied and the locomotive is ready to be trucked and have the final connections made. After the paint shop has made it resplendent in a new coat of Duco spray it is ready for the final test for which it was so painstakingly manufactured.

The methods of construction of the all-welded Diesel Electric locomotive allow a free expansion of welded members, thereby minimizing locked-up stresses. It is therefore possible to expect better performance and availability of the all-welded Diesel Electric locomotive over the riveted steam locomotive, owing to the fact that there cannot be expected any loosened rivets while in operation. Therefore, the life of the locomotive is increased by eliminating many rust starting points, and reducing maintenance cost, as well as adding greatly to the safety of the power units in modern railroading. As illustration, mileages totaling more than 100 millions for all the present Diesels are definite proof of the widespread acceptance of the modern all-welded locomotive in covering services in high or low altitudes, desert heat or sub-zero cold, mountains, prairies, fast and heavily loaded trains.

The past few years have brought many changes in the speed and efficiency of rail transportation. What the new era around the proverbial corner will open up for us we can only guess.

How to Select Electrodes for High-Quality Vertical and Overhead Work

A.W.S. Classes E6010 and E6011 vs. E6012 and E6013

By H. O. Westendarp, Jr.*

Welding from bottom up

Welding from bottom up

WHILE the arc-welding process has thoroughly demonstrated its effectiveness in producing high-quality products at high speeds, there have been instances of weld failures. These failures have been due to a number of causes, but undoubtedly one of the contributing factors has been the mechanical properties of welded joints.

There are only two A.W.S. classes (E6020 and E6030) applying to electrodes designed for welding in horizontal and flat positions. The deposited metal from both these classes of electrode is high in ductility and impact values. Both classes have arcing characteristics resulting in deep penetration and excellent contour of deposited fillet and groove welds.

There are four A.W.S. classes (E6010, E6011, E6012, E6013) applying to electrodes designed for welding in vertical and overhead positions. Two of these classes produce a high-quality deposit, the other two a moderate-quality deposit. There is a decided difference in arcing characteristics of the four classes. It is, therefore, very important that careful consideration be given to the selection of electrodes for vertical and overhead welding of high-quality work.

The high-quality types of electrode for vertical and overhead welding are covered by A.W.S. Classes E6010 and E6011. The former is designed specifically for use with direct current, reverse polarity, and the latter for alternating current. Neither of these classes of electrodes can be operated on both a. c. and d. c. with optimum results. For optimum results, they must be used with the specific power supply for which they are designed. This means that plants using a.-c. and d.-c. welders must order and stock both E6010 and E6011 electrodes if high-quality welds are required.

Possibly in an effort to standardize and to eliminate double stocking, some plants have considered changing from A.W.S. Classes E6010 and E6011 types of electrode to the use of "universal" types. As the name implies, "universal" electrodes can be operated on both a. c. and d. c. and in any welding position. Such electrodes meet A.W.S. Classes E6012 and E6013. However, these electrodes are not recommended for work which must meet highest quality specifications.

* General Electric Co., Schenectady, N. Y.

because no "universal" electrode (E6012 and E6013) can equal the results obtained with A.W.S. Classes E6010 and E6011 electrodes.

The following points will help to clarify the situation:

1. The strength of fillet welds is a function of their gage size and throat dimension.
2. The throat dimension of a given gage size fillet is in direct proportion to the penetration obtained.
3. While penetration can be controlled within certain limits by welding technique, it is primarily affected by electrode arcing characteristics.

Both A.W.S. Classes E6010 and E6011 electrodes have a digging arc which results in deep penetration and consequently strong welds. The "universal" types of electrodes (A.W.S. Classes E6012 and E6013) have a soft arc which results in light to medium penetration reaching just about to the corner of fillet welds. The detriment of "notch effect" (caused by incomplete penetration) on the strength of a welded joint cannot be overemphasized.

In addition to the strength of the fillet weld, as measured by the gage size and the throat dimension, the over-all strength of the joint is also affected materially by the stress flow lines through the joint. These stress flow lines are affected by the cross-sectional profile of the fillet weld which is established by the arcing characteristics of the electrode and the welding technique.

Both A.W.S. Classes E6010 and E6011 electrodes when used with proper welding technique will inherently produce fillet welds in the vertical and overhead positions which are relatively flat and result in good stress flow lines. However, A.W.S. Classes E6012 and E6013 electrodes inherently produce fillet welds which are definitely convex, resulting in stress concentrations at the toe of the fillet weld.

A.W.S. Classes E6012 and E6013 electrodes were primarily developed for general-purpose job welding and for work having from average to poor fit-up of joint. They are also particularly suited to welding of thin metals.

For convenience, the advantages and disadvantages of "universal" electrodes are summarized below, together with similar characteristics of "high-quality" vertical and overhead electrodes.

Advantages of "Universal" Electrodes, A.W.S. Classes E6012 and E6013:

1. Will operate with both a. c. and d. c.
2. Easy to weld with.
3. Good for poor fit-up work and thin metals.
4. Easy slag removal.
5. Good appearance of deposit. (Fine ripple.)
6. Simplified ordering procedure. (Only one electrode for a. c. and d. c.)
7. Simplified warehousing. (Only one electrode for a. c. and d. c.)

Disadvantages of "Universal" Electrodes:

1. Low ductility, as compared to high-quality electrode. (17 to 22%.)
2. Penetration just reaches corner of fillet weld. (With correct welding technique.)
3. Convex fillet welds build up stress concentrations at toe of fillet weld.
4. Convex fillet welds waste metal in bulge of fillet.
5. Metal deposited in bulge reduces linear footage speed.
6. Low impact values compared to high-quality electrodes. (Charpy 26 to 28 ft.-lb.)*

Advantages of High-Quality Electrodes, A.W.S. Classes E6010 and E6011:

1. They have a digging forceful arc.
2. They produce deep penetration.
3. They produce flatter fillet welds, having less stress concentration at toe of fillets.
4. They conserve electrode material by depositing relatively flat fillets.
5. They increase linear footage welding speeds by producing relatively flat fillets.
6. They have good ductility. (22 to 27%.)
7. They have high impact values. (Charpy 30 to 34 ft.-lb.)*

Disadvantages of "High-Quality" Electrodes:

1. Limited to operation on either a. c. or d. c.
2. Somewhat harder for green operators to use.
3. Slag removal more difficult.
4. Rougher surface appearance of deposit. (Coarse ripple.)

It should be noted that strong welds can be produced with Classes E6010 and E6011 electrodes but that even with proper technique the characteristics of Classes E6012 and E6013 electrodes are such that penetration just about reaches the corner of the joint and fillet welds made with these "universal" electrodes are inherently convex.

Electrode development laboratories are working on the problem of developing a "universal" electrode which will also possess all the advantages of the Classes E6010 and E6011 electrodes, such as deep penetration, high impact values, ability to produce relatively flat fillet welds, etc. However, tests indicate that no such electrode exists at present. These tests made on practically all makes of electrodes show that without exception all of the electrodes fall into one of the two groups discussed above. That is, they are either "universal" types which have soft arc characteristics, or they are high-quality vertical and overhead types which have a digging arc, deep penetration, etc. All electrodes capable of operation on both a. c. and d. c. require definite sacrifices in weld quality as compared to electrodes specifically designed for a. c. or specifically designed for d. c.

The advantages of a standardized ordering and warehousing procedure are recognized, and the use of "universal" type electrodes is inviting from that standpoint, as well as from the standpoint of easy slag removal fine surface appearance and adaptability to poor fit-up work. However, where weld quality is an important factor, good welding practice continues to support the use of high-quality electrodes specifically designed for d. c. or specifically designed for a. c. as covered by A.W.S. Classes E6010 and E6011, respectively.

This discussion has been presented to permit users to analyze the problem immediately, however the ultimate answer may be in the A.W.S. filler metal specifications currently A233–43T. A fine job has already been done, but it seems advisable to consider additions to the specifications in order to segregate arc welding electrodes which will meet the same mechanical property requirements of deposited weld metal, but which vary widely in penetration and profile characteristics with resulting affect on strength of joint. To this end consideration of the following is suggested:

a. Longitudinal fillet weld shear test.
b. Transverse fillet weld shear test.
c. Impact test.

Such tests have been used to approve Class E6020 and other electrodes for "deep fillet" welding in order to speed up war production. It seems in order to suggest that similar test requirements be set up in order to assure quality of welded joints.

* A great deal of attention is now being directed to the importance of high impact values.

Practical Ways to Improve Machine Cutting

By H. H. Moss*

MECHANIZED oxyacetylene cutting has reached such a high stage of development that truly remarkable performance has become commonplace. Steel, from light-gage sheet to 50-in. risers, is sliced with a speed, efficiency and economy that only a few years ago would have seemed wholly fantastic. If the operator of a cutting machine finds that his results still leave something to be desired, it may be possible he is overlooking some apparently minor adjustment of the machine or blowpipe that is actually much more important than it appears to be. The following discussion and illustrations may help him discover the trouble.

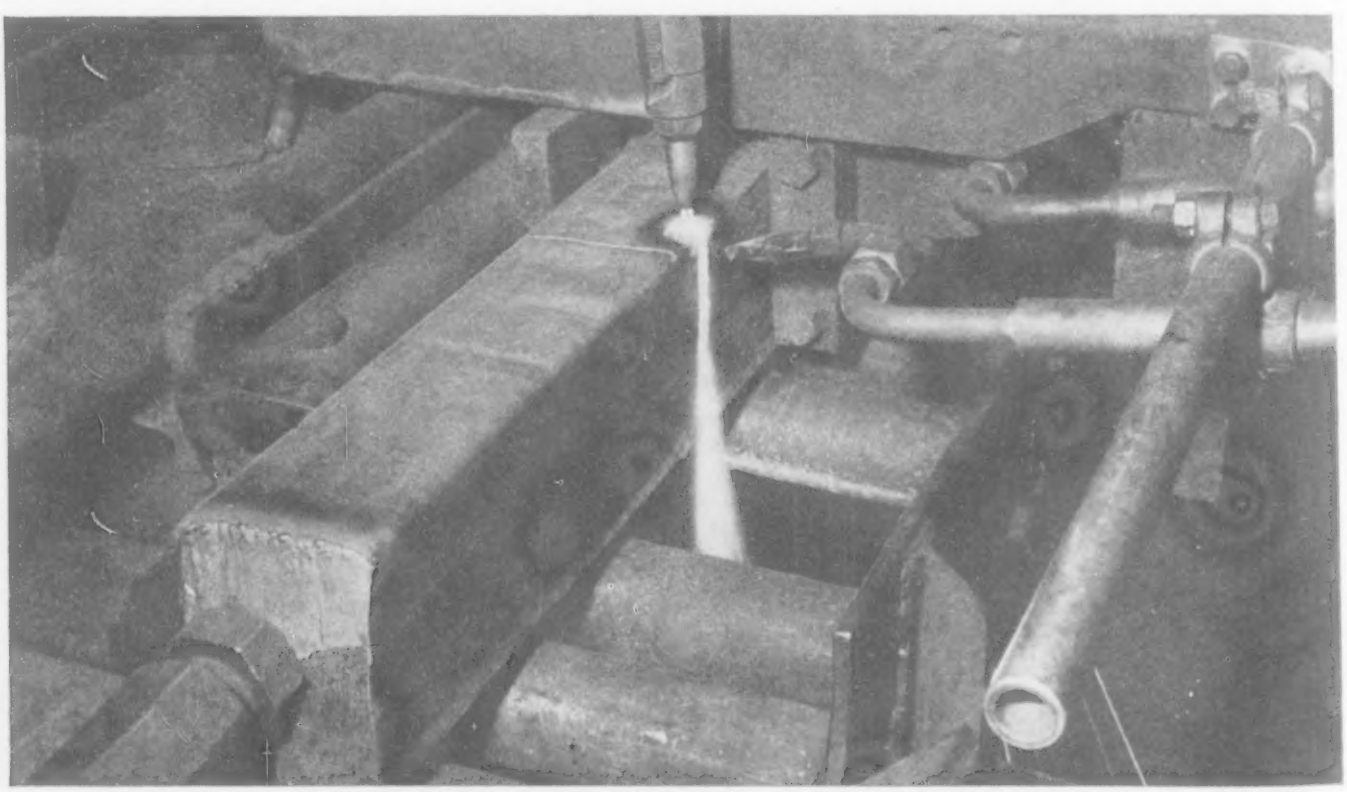
The first point for the operator to learn and remember is to read, reread and then read again the manufacturer's instructions or directions for operating for both his cutting blowpipe and his cutting machine. If these instructions are carefully followed, serious difficulty will rarely be experienced. Trouble usually arises only when there is lack of precision in making adjustments to the blowpipe or machine, or just plain carelessness on the part of the operator.

* The Linde Air Products Co., Newark, N. J.

Nozzle Selection

Select the correct-size nozzle for the thickness of metal to be cut, as recommended by the manufacturer of the blowpipe to be used. Most manufacturers have several different series of nozzles for each blowpipe. It is important to make a selection from the proper series, as each series has distinctly different operating characteristics. Make sure that the nozzle selected is clean and in good condition. If it requires cleaning, carefully follow the manufacturer's recommended procedures, particularly with regard to the use of correct drills or cleaning tools.

A nozzle with four (or less than four) preheat flame holes should be so positioned in the blowpipe head that two of the preheat flames will be directly on the line of cut—one immediately ahead of the cutting-oxygen jet or stream and the other behind it, as shown in Fig. 1. This arrangement will give the most efficient preheat distribution, which is an appreciable factor in gas economy. It also helps to preserve the squareness of the upper edge of the cut surface. Positioning is not important if the nozzle has more than four preheat flame holes.



The Cutting-Oxygen Stream Should Enter the Metal in About the Same Relative Manner That a Band Saw Enters a Piece of Wood

Flame Adjustment

Adjust the oxygen and acetylene regulators to deliver the pressures recommended in the manufacturer's cutting chart for the size nozzle and the thickness of metal to be cut. The cutting-oxygen pressure given in most cutting charts is the pressure at the blowpipe. Therefore, the regulator pressure—that indicated on the gages— may have to be increased slightly (about 1 to 3 psi.) depending on the length of hose.

After adjusting the regulators, light the blowpipe and adjust the preheat flames to neutral and to the length specified on the cutting chart for the particular nozzle selected. It will be noted on the chart that the length of the neutral preheat flame varies considerably with different styles and sizes of nozzles. The inner cones of the neutral flames should appear round, full and sharply defined, as at *A* in Fig. 2. Now open the cutting-

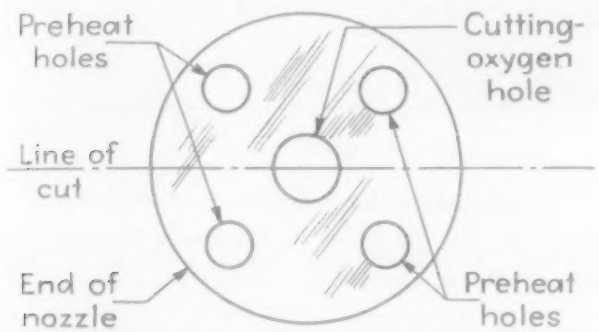


Fig. 1—Position the Nozzle in the Blowpipe Head So That Two Preheat Flames Will Fall Directly on the Line of Cut—One Immediately Ahead of the Cutting-Oxygen Jet and the Other Behind It

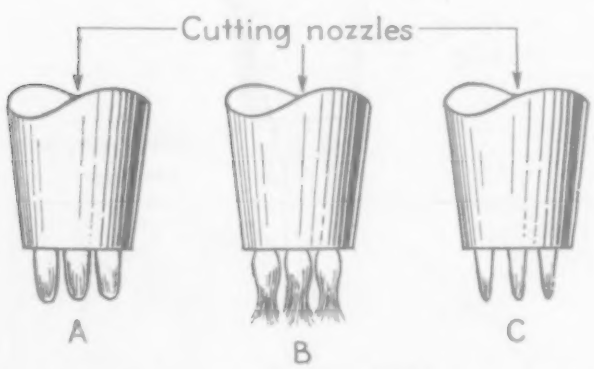


Fig. 2—Inner Cones of the Neutral Preheat Flame (*A*) Become Ragged (*B*) When the Cutting Oxygen Is Turned on. When Adjusted Back to Neutral, They Become Sharp-Pointed (*C*). This Is the Correct Setting for General Cutting

oxygen valve. This will cause the inner cones to become bushy and ragged, as at *B* in Fig. 2, and to lose their characteristic neutral sharpness. With the cutting oxygen still turned on, adjust the preheat flames back to neutral again. The tips of the cones will then become pointed, as at *C* in Fig. 2. This is the correct setting of the preheat flames for all general cutting.

The final flame adjustment should always be made with the cutting-oxygen valve open. This applies, of course, to a two-hose setup only. With a three-hose setup, that is, one with a separate hose line and an independent oxygen supply for the cutting oxygen, the neutral adjustment of the preheat flames is unaffected whether the cutting-oxygen valve is open or closed.

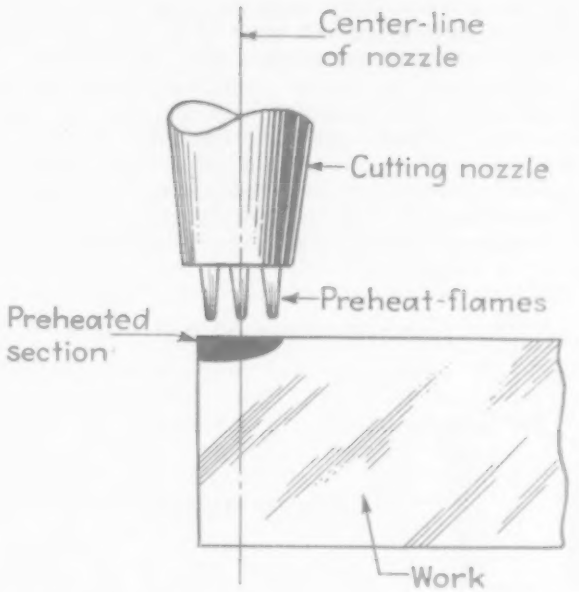


Fig. 3—When Starting a Cut, Heat a Spot of Metal Almost to the Melting Point, with the Inner Cones Almost But Not Quite Touching the Surface

Starting the Cut

The initial step in starting the cutting action is to heat a small spot of the metal to a bright red heat. Position the lighted blowpipe, with the cutting-oxygen valve closed, so that the flames will fall on the surface of the plate near the edge (see Fig. 3) and with the tips of the inner cones almost but not quite (about $^1/_{32}$ in. away) touching the metal. Allow the blowpipe to remain in this position until the metal is almost ready to melt. Then quickly move the blowpipe to one side so that the center line of the nozzle is about $^1/_8$ in. from the end of the work, as shown in Fig. 4, and at the same time turn on the cutting oxygen and start the machine.

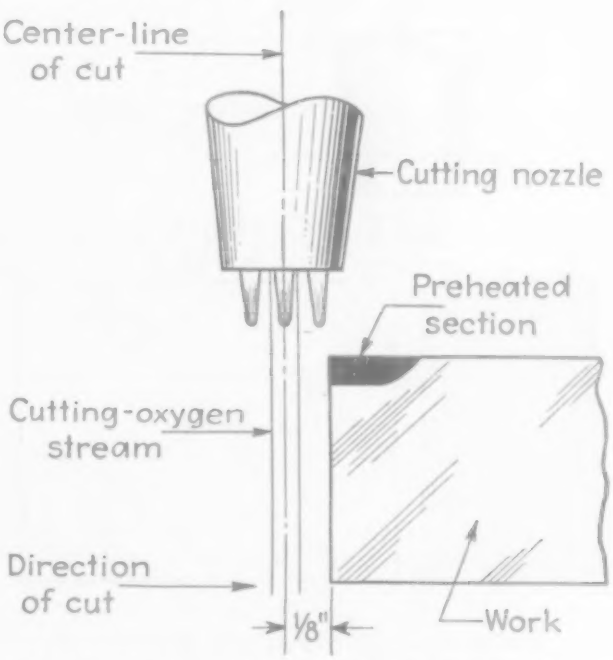


Fig. 4—Quickly Move the Blowpipe So That the Center Line of the Nozzle Is Just Beyond the End of the Plate, and at the Same Time Turn on the Cutting Oxygen and Start the Machine

If the top surface of the work has been sufficiently preheated, cutting action will start as soon as the oxygen stream moves over and touches the preheated top edge of the work. The above operations must be done quickly before the preheated spot of metal has time to cool. This method is generally termed a "flying start" and can be used successfully on metal thicknesses up to about 6 in.—or even greater thickness with practice.

If an attempt is made to start the cutting action without moving the blowpipe to one side, a kickback of the molten metal will almost surely occur before the cutting-oxygen jet pierces through the metal thickness, as shown in Fig. 5. The flying molten metal will more than likely cause damage to the nozzle. A bad gouge may also result from attempting this kind of start.

It should be remembered that the center line of the nozzles is also the center line of the cutting-oxygen jet

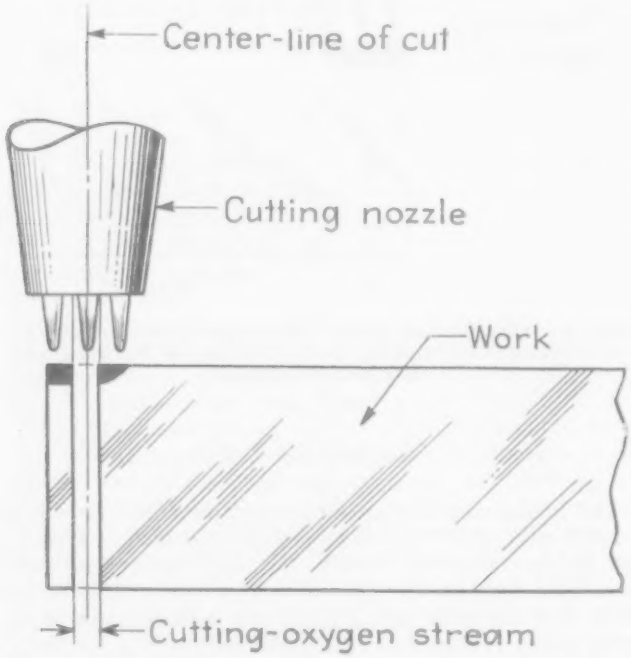


Fig. 5—If Attempt Is Made to Pierce Directly Through the Metal Thickness Instead of Making a "Flying Start," Slag, or Molten Metal May Kick Back and Damage the Nozzle, Blowpipe or Machine

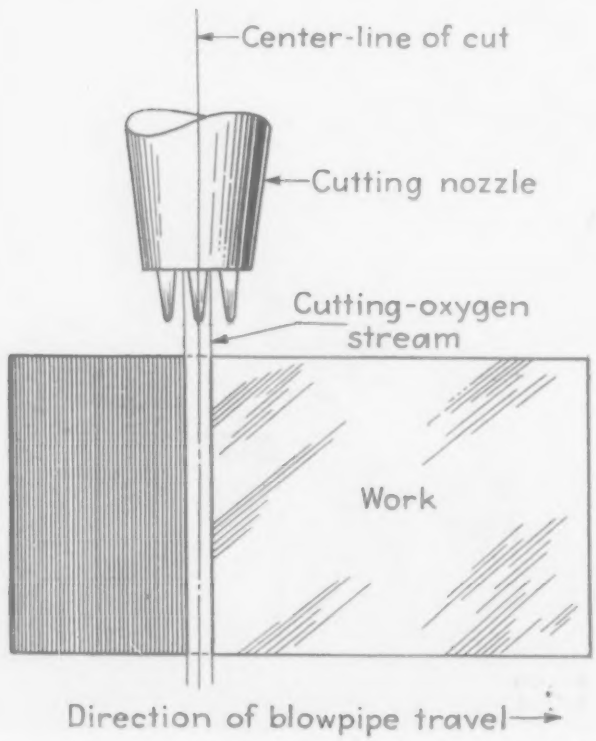


Fig. 6—When Pressure, Speed and Other Adjustments Are Correct, Draglines Will be Barely Visible and Will Be Vertical —That Is, the Lag Will Be Zero

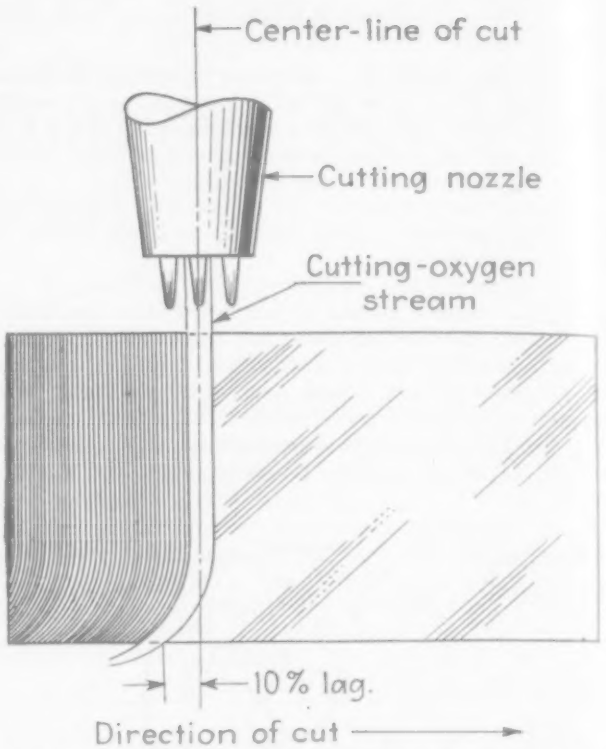


Fig. 7—A 10— Lag Is Usually Considered Satisfactory for Average, Run-Of-Shop Cutting, Though a Greater Lag May Be Entirely Satisfactory for Certain Types of Jobs

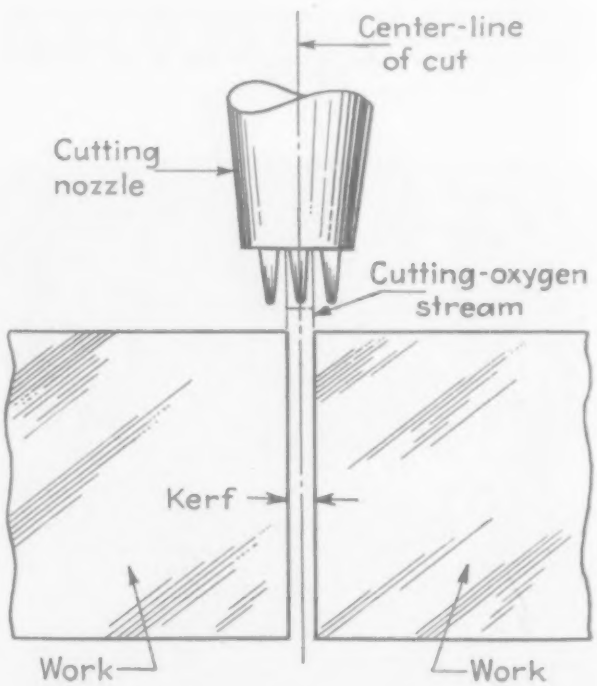


Fig. 8—The Slot or Groove Formed in the Metal by the Cutting-Oxygen Stream Is Called the Kerf. Characteristics of the Kerf Vary Considerably with Different Styles and Types of Nozzles

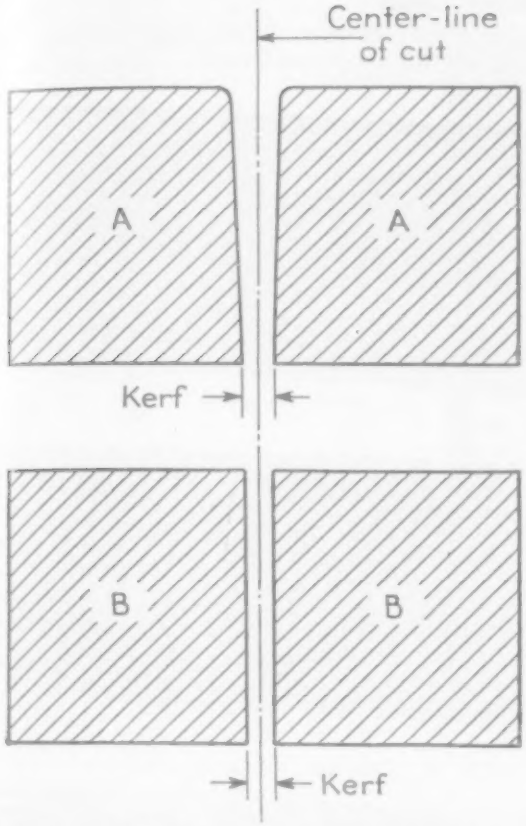


Fig. 9—Some Kerfs Taper from Top to Bottom As Shown (Exaggerated) at (*A*), and Have Rounded Top Edges. Other Kerfs Are Very Narrow (*B*), with Practically No Taper and with Sharp, Square Top and Bottom Edges

and that the jet should travel into the work in about the same manner that a band saw travels into a piece of wood. If the jet fails to penetrate all the way through and the cut is "lost," quickly turn off the oxygen and acetylene to prevent a molten metal kickback. Back up the machine and make a new flying start.

Whenever possible, before making an actual production cut, make a trial cut on a piece of scrap metal of

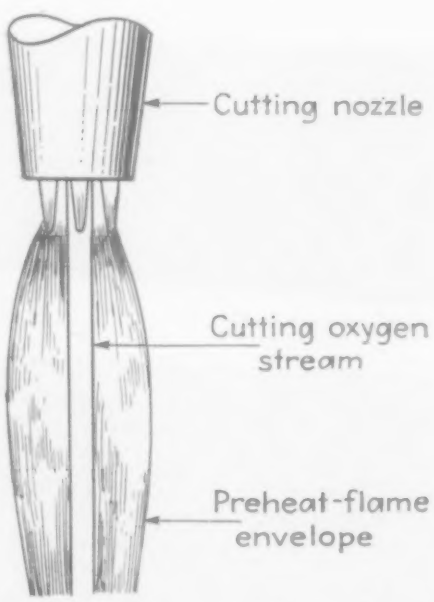


Fig. 10—The Path of the Cutting-Oxygen Stream Through the Outer Envelope Should Show up Straight and True, with a Uniform Diameter Clear to the End of the Flame

the same thickness and composition as the work. Carefully examine the face of the cut. If correct procedures have been followed and all adjustments have been made properly, the surface will be smooth and square, the draglines will be barely visible and will be vertical, the edges will be sharp and straight, and the little oxide present will be easy to remove. If, however, any detail of operation or adjustment was not correct, the result will be at once apparent on the cut surface. For example, the effects of too high or too low oxygen pressure, too fast or too slow travel of the machine, or preheat flames too near or too far from the surface will be plainly visible.

Some of the more common faults of the inexperienced cutting machine operator are shown in the illustrations which follow. Study these pictures carefully and compare your cuts with them. If your results have not been wholly satisfactory, perhaps these pictures will indicate to you an adjustment you have not been making properly which is the source of your trouble.

Per Cent of Lag

Where smoothness and squareness—that is, quality—of the cut surface is the prime consideration, machine and blowpipe should be so adjusted that the draglines will be barely visible and will be straight up-and-down. In other words, the lag should be zero, as shown in Fig. 6. However, if economy as well as quality is to be considered, it may frequently be found that a cut will be entirely satisfactory for certain jobs when the rate of

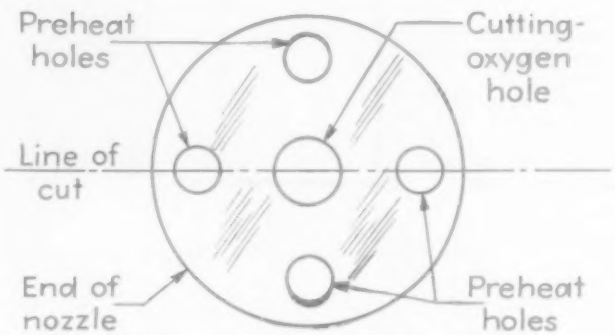


Fig. 11—For a Bevel Cut, Position the Nozzle So That Two Preheat Flames Fall on Either Side of the Line of Cut. Compare this with the Position for a Vertical Cut Shown in Fig. 1

travel of the blowpipe is stepped up so that the lag is greater than zero but the quality of the cut is not otherwise lowered. Obviously, this will result in increased speed and lower oxygen and acetylene consumption for a given length of cut.

In general, cuts having a 10% lag (10% of the metal thickness), as shown in Fig. 7, are satisfactory for average run-of-shop work and are considered standard as to quality. Quite often cuts with a lag of considerably more than 10% will be suitable for a particular purpose, with proportional savings in time and gases. Just how much lag can be permitted depends on the type of cut surface required. If the lag is too great, the cut surface will lose its squareness, draglines will be more pronounced and considerable time and effort may be required to break or cut the scrap metal from the work piece at the final uncut corner. The greater the lag the greater the possibility that the cut will be lost frequently.

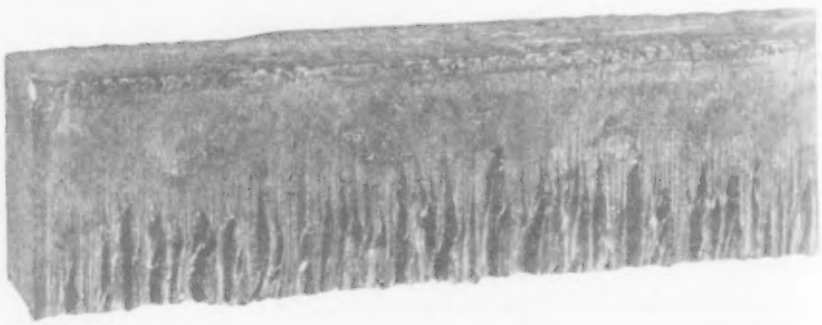
Typical Examples of Machine Cutting

These specimen cuts, in 2-in. low-carbon steel, show the results of correct and incorrect adjustments of the cutting blowpipe or cutting machine.

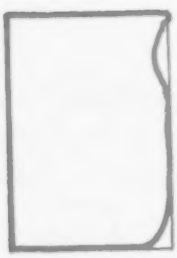
END VIEW

Correct Adjustments
Top edge sharp.
Cut surface smooth, draglines barely visible.
Face of cut square.
Oxide, if any, easily removed.
Bottom edge sharp.

Cutting Speed Too Slow
Top edge melted and rounded.
Face of cut irregular, with deep gouges.
Bottom edge very rough and irregular.
Possibly oxide tightly adhering to the bottom surface of the plate.



Cutting Speed Too Fast
Top edge fairly sharp but with slight beading.
Draglines have pronounced backward rake.
Considerable undercutting just below top edge.
Bottom edge rounded.
Final corner uncut.



DIRECTION OF CUT

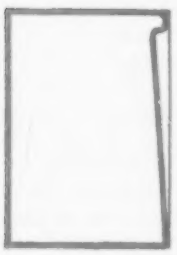
END VIEW

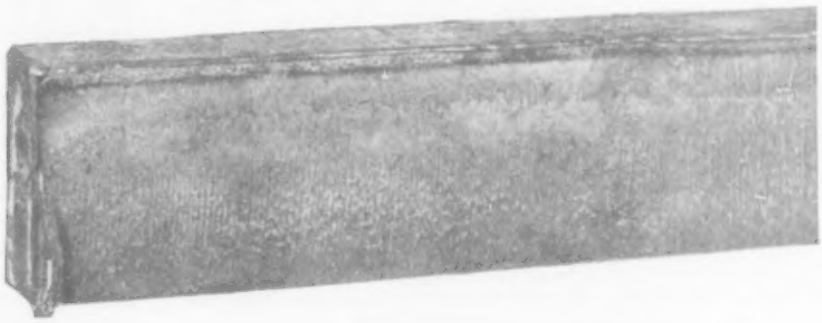
Preheat Flames Too High Above the Work
Top edge badly melted and rounded over.
Slight undercutting just below top edge.
Face of cut otherwise square.
Bottom edge sharp.

Preheat Flames Too Close to the Work
Top edge slightly rounded.
Heavy beads along top edge.
Face of cut smooth and square.
Bottom edge sharp.
Could be considered a fairly good cut.

Cutting-Oxygen Pressure Too High
Even bead entire length of top edge.
Considerable undercutting below top edge.
Noticeable taper from top to bottom of cut.
Face of cut smooth.
Bottom edge sharp.

Preheat Flames Too Long
Top edge rounded over.
Heavy bead entire length of top edge.
Considerable taper from top to bottom of cut.
Face of cut smooth, with draglines barely visible.
Bottom edge sharp.





Characteristics of Kerf

The slot or groove formed in the metal by the cutting oxygen stream is called the kerf (see Fig. 8). When a cut is to be made to exact dimensions, the width and cross-sectional contour of the kerf must be carefully taken into consideration. Kerf characteristics will also have a bearing on the choice of nozzle, since there is considerable variation in this respect between different styles and types of nozzles. For example, in cuts made using one type of nozzles the kerf will taper slightly from top to bottom and the top edges may be rounded over, as shown at *A* in Fig. 9, which is exaggerated for purposes of illustration. On the other hand, cuts made with a more appropriate series will have a very narrow kerf, with little if any taper and with sharp, square top and bottom edges.

The kerf width and shape will also be affected by the uniformity and smoothness of the cutting-oxygen stream.

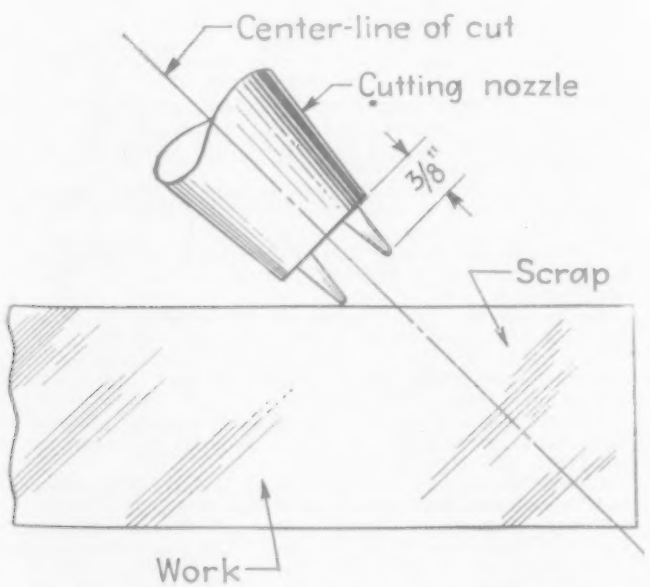


Fig. 12—Since a Larger Volume of Preheat Is Required for a Bevel Cut Than for a Vertical Cut, Adjust the Flame So That the Inner Cones Will Have the Longest Possible Length

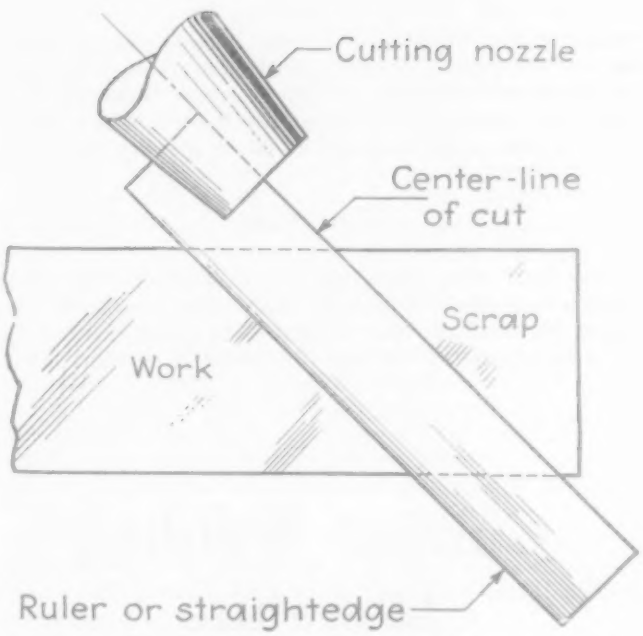


Fig. 13—Use a Ruler or Straightedge, Held Parallel to the Center Line of the Nozzle, to Position the Blowpipe So That a Cut of the Desired Bevel Angle Will Fall Entirely Within the Plate

During the cutting operation small particles of molten metal or oxide may adhere to the end of the nozzle, causing a slight obstruction to the flow of oxygen through the orifice, which will in turn interfere with the smoothness and symmetry of the oxygen stream as it enters the metal. This condition may affect not only the squareness of the cut face but also the top edges of the cut. For this reason it is important that the end of the nozzle be inspected frequently and thoroughly cleaned as often as necessary.

A simple method of checking the smoothness of the oxygen stream is to light the preheat flames, adjust them to neutral and then open the cutting-oxygen valve. The path of the oxygen stream as it passes through the outer envelope of the preheat flame will be clearly visible, as shown in Fig. 10. View it from both the side and the

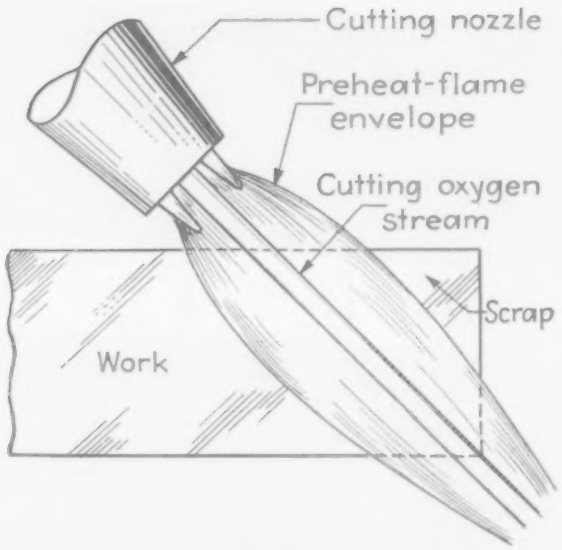


Fig. 14—Another Method of Determining Whether or Not a Bevel Cut Will Fall Entirely Within the Plate Is to Observe the Path of the Cutting-Oxygen Stream Through the Outer Envelope of the Preheat Flame

front of the blowpipe. If the cutting-oxygen hole is clean, the path of the oxygen stream through the outer envelope will show up straight and true, with a uniform diameter clear to the end of the flame. The operator should make this check before starting every cut.

Bevel Cuts

For bevel cuts there are two or three details of adjustment and manipulation that differ somewhat from those for vertical cuts. It should be borne in mind that in a bevel cut the thickness of metal at the kerf is considerably thicker than the thickness of the plate on which the cut is made. This should be taken into consideration when selecting the size nozzle to use and when adjusting the pressure and setting the machine speed.

The most efficient distribution of the preheat will be obtained (with a four-hole nozzle) if the nozzle is positioned in the blowpipe head as shown in Fig. 11, so that two preheat flames will fall on each side of the line of cut but none directly on the line of cut. Compare this setting with that for a vertical cut (see Fig. 1).

A greater volume of preheat is required for a bevel cut than for a vertical cut. This is because some of the heat is lost due to the fact that the preheat flames strike the plate surface at an angle, which causes a "bouncing-off" effect. For angles up to 45° sufficient heat may be obtained by forcing or lengthening the inner cones to as much as $^{5}/_{16}$ or $^{3}/_{8}$ in. if possible (see Fig. 12). For angles of more than 45° in heavy thicknesses it may be found necessary to provide extra heat from an auxiliary source—either from a second blowpipe or by preheating the metal along the line of cut before making the actual cut. The tips of the inner cones nearest the plate surface should be close to but not quite touching the plate (about $^{1}/_{32}$ in. from the surface).

When adjusting the blowpipe into position to make the desired angle of bevel, be sure that the entire cut will remain within the plate. This may be determined by moving the blowpipe just beyond the end of the plate and placing a ruler or straight edge along the center line of the nozzle, as shown in Fig. 13. Another method is to observe the path of the oxygen jet through the outer envelope of the preheat flames when the blowpipe is near the end of the plate just before starting the cut, as shown in Fig. 14.

If all adjustments have been properly made, the face of a bevel cut, like that of a vertical cut, will be smooth and the edge will be sharp. If adjustments are not correct, however, the results will make themselves manifest in the same manner as those in vertical cuts.

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(*Continued on page 528*)

Coast Guard Inspection of Welding in Shipbuilding*

By R. D. Schmidtman, Commander, U. S. C. G.†

I. Introduction

A. Historical Sketch of Welded Shipbuilding in Coast Guard

WELDING as a means of fabrication in the construction of ships was first given serious consideration during the latter days of the first World War at which time the Shipping Board had under preparation a series of designs for completely welded sea-going cargo vessels. The close of the first World War terminated this work and welding as a major factor in shipbuilding did not re-appear until early in the 1930's at which time several small (about 400 ft.) completely welded vessels were constructed. Welding had already been introduced in shipbuilding prior to this time but was of a minor nature only, being used on such things as minor hull fittings, secondary foundations, piping, etc. In this connection, it should be pointed out that the Coast Guard was fairly early in its adoption of welding in shipbuilding, the cutter Northland, built by the Newport News Shipbuilding and Dry Dock Company in 1927, having had welding employed in her construction to a minor degree. In general, the use of welding in shipbuilding in the Coast Guard has just about paralleled the experience of the Navy in this respect and, as usual, there has been considerable reluctance on the part of both services to accept this or any other new process until it has been thoroughly tried and proved. Thus, it is understandable that the first all-welded ships to be constructed for the Coast Guard were not laid down until 1939. Since that time, however, practically every ship which has been built for the Coast Guard has been designed as an all-welded ship. The "all-welded" policy of the service, however, has been modified in certain specific instances during the present emergency due to the inability of certain yards which were scheduled to build vessels to properly construct an all-welded ship. In these instances, riveting has been permitted to a limited degree.

B. Coast Guard Welding Standards

The standards for welding used by the Coast Guard in shipbuilding are the "General Specifications for Building Vessels of the U. S. Navy," Appendices 5 and 7,‡ together with Leaflet Material Specifications prepared and published by the Navy Department. These specifications govern every phase of the welding operation and also control the proper use of welding in the comprehensive problem of constructing a vessel. Material Specifications cover Electrodes and Base Metals, and the General Specifications prescribe in detail the procedure for operator Qualifications, Process Qualifications, Design Procedure, and Practical Production Welding.

C. Training and Experience of Inspectors

In regard to the inspectors themselves: Any consideration of the personnel engaged in inspection of welding and the construction of ships in general for the Coast Guard at this time must of necessity be divided into two classifications: (1) The normal or peace-time condition, and (2) the present or war-time condition. The organizational plan for shipbuilding inspection units is the same in both catagories although the peace-time units are usually considerably smaller in number of personnel than those which are being employed at the present time. At the head of the inspection unit is the "Coast Guard Resident Inspector," that being his formal title. Under normal conditions the Resident Inspector is a Coast Guard commissioned officer who has had special training in Naval Architecture and Marine Engineering usually with both practical and theoretical experience in shipbuilding and in welding. It has been the policy of the Coast Guard for several years past to train these officers in the U. S. Navy Post Graduate Course in Naval Construction at the Massachusetts Institute of Technology from which the Navy obtains all of its constructors in peace time. For the duration of the present emergency Resident Inspectors are not limited to these requirements, however, but they may be Coast Guard commissioned officers with extensive engineering experience who are considered to be capable administrators. The Field Inspectors, or assistants to the resident inspector, are normally warrant officers or chief petty officers with considerable service who have had experience in boat and shipbuilding and in marine engineering installation and operation. Under the peace-time setup it was the practice to assign inexperienced chief petty officers to inspection units for training under the more experienced personnel until qualified to serve as assistants to the resident inspector. Since the beginning of the present war, however, comm issioned officers, warrant officers, enlisted personnel and in some cases civilian personnel have been assigned to inspection units as assistants to the resident inspector. While an attempt is made to assign only personnel who are either experienced in shipbuilding or who by reason of their work in civilian life prior to induction into the Service are adaptable to inspection duty, many of the personnel actually assigned are inexperienced. In an effort to expedite the war-time building program, the number of assistant inspectors assigned has been increased many fold. In addition to the regularly assigned inspectors, the key engineering personnel assigned to vessels building are usually sent to the building yard early in the construction period and these are utilized as additional inspectors.

II. Inspection of Welding

The entire scope of the inspection of welding in shipbuilding may be broken down into 6 specific functions:

* Presented before January 18th Meeting, Toledo Section, A. W. S.
† Coast Guard Resident Inspector, Toledo Shipbuilding Co.
‡ General Specifications for Inspection of Materials, Appendix VII, Welding, U. S. Navy Dept.
Appendix 5, General Specifications, Bureau of Ships.

1. Approval of pans.
2. Review and approval of the welding sequence.
3. Qualification of the welding process or processes.
4. Qualification of welding operators.
5. Inspection of production welding.
6. Post-welding tests.

A. Approval of Plans

Considering these separate functions in order: The approval of plans as related to welding involves a minute study of all phases of the design of the vessel including types of welds, size of welds, and design of the structure for welding. All of these items are carefully checked and the plans approved by a qualified inspector before they are released to the builder. This function may be the duty of the resident inspector at the contractor's plant if the contractor is also the design agent, or if the design and plans are made by a separate agency then this inital inspection and approval is accomplished by an inspector assigned to the office of the design agent.

B. Review and Approval of Welding Sequence

The second function, that of approval of the welding sequence is possibly the most important single item in the entire inspection procedure. A "welding sequence" is usually more than just that. It is generally an "erection sequence" as well, since, the two functions are intimately associated, one with the other. A welding sequence is, briefly, a long-range plan—which considers the vessel from start to finish—of the order in which welding will be accomplished and in which the various parts of the vessel will be put together both in fabrication and erection in order to accomplish the required result; which is a homogeneous and well-bonded structure with a minumum of distortion and residual stress, and conforming as nearly as possible to the molded lines established by the designer. If it were possible to place a completed ship in an annealing furnace and fully anneal or even normalize the structure after welding, the need for meticulous care in establishing and following a welding sequence would be largely eliminated, but since the annealing of a steel structure the size of a ship is obviously impossible the sequence of welding operations becomes of paramount importance as the only means yet devised to exercise control of distortion. The principle followed in establishing welding sequences is extremely simple and is the same principle which is followed in the welding fabrication of the simplest and smallest of welded structures. The welding should be started from a central point and carried toward the boundaries; always welding toward freedom—never toward fixity if it can be avoided; never welding past an unwelded butt or seam or other unwelded part of the structure.

To facilitate the welding of large vessels, such as those exceeding 200 feet in length, the entire structure is divided into two or more sections and each of these is regarded as a separate welded entity, as though each were a ship in itself. Each is welded by means of a separate sequence although these are usually similar and the sections are later connected at expansion joints which are trimmed, fitted and welded last of all. In smaller vessels the entire vessel is considered as a whole, that is, as a single section and welding proceeds forward and aft from amidships to the bow and stern. In both large and small vessels the large sections are subdivided into smaller logical structural units. The smaller units usually comprise single compartments, if fairly large, or a number of compartments, if small, located between two main transverse bulkheads and two principal decks. Each of these small structural units is dealt with separately and a sequence prepared for each. The small units might be likened to a child's building blocks, which, if properly assembled, may be made into a solid structure, but, which obviously cannot be erected in any manner except from the bottom upward; likewise the sequences for the various smaller subdivisions must be integrated into a logical over-all sequence if an undistorted vessel is to be obtained. Within each of the smaller sequences, in turn, there are other sub-sequences for the fabrication of bulkheads, decks, and major foundations.

In the "Mackinaw," the vessel which the Toledo Shipbuilding Company has under contract for the Coast Guard at the present time, the welding sequence considers the ship as a single unit and subdivides the vessel into thirty-three small structural units, for each of which a sequence has been carefully worked out.

In the examination and review of a welding sequence by the inspector, it is obvious that a minute check must be made of all of the main structural members involved in the construction of the vessel. Hundreds of plans must be studied and no detail overlooked. The sequence must be clear, concise, logical and must follow good welding engineering practice considering the type of vessel involved. The inspector, in the course of his task of reviewing, usually participates in the actual planning of the sequence although *that* is really the contractor's responsibility. The preparation and checking of a welding sequence for a vessel of any size is a long and tedious job but a most important one if distortion to be kept to a minimum. Finally, during the construction of the vessel the inspector must, with the Contractor's Welding Engineer, always be on the alert to detect the presence of unusual distortion which may indicate that a change in the welding sequence is desirable and, in this connection, the welding sequence must be considered extremely flexible and subject to change at any time.

C. Qualification of Welding Process

The third function, the Qualification of the Welding Process, considers every element entering into the fabrication of proposed welded joints. Under this heading there is the Filler Material or Electrode which is covered by Material Specifications, the Base Metals or parts to be joined which are also covered by Material Specifications, the Welding or Brazing Process itself, and consideration of whether or not the materials to be joined are similar or dissimilar, the equipment to be used in the prosecution of the process and a combination of the equipment and processes in cases of Automatic and Semi-Automatic Procedure such as unionmelt and resistance welding.

D. Qualification of Operators

The fourth function, Qualification of Welding Operators, is covered in complete detail by Navy Dept. General Specifications for Inspection of Material Appendix VI, which enumerates the qualification tests for all types of welding, such as metal arc and gas welders. It is the duty of the inspector to see that no operator is allowed to weld on any Government Work for which he is responsible unless that operator has passed an appropriate Qualification Test. The qualification tests are six in number and cover all types of structural production welding. In all of the Qualification Tests, the operator is required to use the equipment which is to be used in the actual production work and any operator whose ability to weld properly is questioned by

the inspector may be required to be re-tested at any time. The first and simplest test involves the making of a 60° double bevel groove butt weld in $^3/_8$-in. plate reinforced with a backing strip. This test may be taken in any of the three positions; flat, vertical and overhead, qualifying the operator to perform production welding in these positions. Five degrees warpage is the maximum allowed and two specimens of the welded plate, a face-bend and a root-bend are tested. This test entitles an operator to weld plate $^3/_4$ in. or less in thickness in various positions as qualified.

The number 2 test involves a 25-to-35° single bevel butt weld in $1^1/_2$-in. plate reinforced with a backing strip. This test may be taken in either the flat or horizontal positions and may be combined with the number 1 test in the vertical position to qualify an operator for welding on plate of unlimited size in the various positions. The 5° maximum warpage still obtains and two side-bend specimens are taken from the welded sample.

The number 3 test involves the welding of a pipe of about $3^1/_2$-in. diameter with a 45° double bevel butt with backing ring or slip-on sleeve with double fillet depending on the details used in production. The weld is to be made with the pipe both in a vertical and a horizontal position placed 6 in. from two adjacent bulkheads and with the weld not more than 44 in. from the base connection. The pipe after welding is subjected to a hydrostatic pressure corresponding to a hoop stress varying from 15,000 to 40,000 pounds per square inch depending upon the material in the pipe and computed from the formula: $P = \frac{S \times 2t}{D}$ where:

P = hydrostatic pressure
S = hoop stress required
t = wall thickness of pipe
D = inside diameter of pipe.

In some cases a macroscopic examination of an etched specimen to indicate fusion, freedom from cracks, etc., is required. This test qualifies the operator in various positions on piping and tubing $^3/_{16}$ in. or less in wall thickness.

Test number 4 is similar to number 3 but is made on 6-in. pipe. The pipe again is welded both in the horizontal and vertical positions and is placed 12 in. from two adjacent bulkheads with the weld located not more than 6 in. from the base connection. The weld to be made is a 45° double bevel butt with a backing ring. Four specimens at specified points are taken from the pipe and bent in the testing jig; two face bends and 2 root bends. This test qualifies the operator for piping, tubing, and plate of unlimited thickness.

The number 5 test is for tack welders only and involves the laying of tacking beads in a 60° double bevel butt joint with a backing strip on $^3/_8$-in. plate.

Test number 6 is a special test for welding metals of high conductivity and is not in general use. Tests 1 through 4 are those most commonly used. Welders to be employed on the welding of galvanized materials must be *tested* on galvanized material. Each specimen required to be tested is bent in a jig around a $^3/_4$-in. radius 180° upon itself. Any specimen which, when bent in the testing jig or before bending shows a crack or opening exceeding $^1/_8$ in. in any direction shall be rejected. No elongation data is required.

E. Inspection of the Actual Production Welding

The fifth function, the visual inspection of production welding, is carried on through the entire period of construction and is the most important function of the field inspectors in connection with welding. First of all, a careful check must be maintained at all times to assure that the welding sequence is being properly followed. Second, a constant and meticulous check must be maintained on the size and type of welds being made to insure that they are as specified on the approved drawings. This procedure includes a close check of fit-up, proper edge preparation and use of backing strips prior to welding, as well as the use of adequate hardware such as clips, saddles, strongbacks, wedges and studs, for proper spacing and alignment. In the case of intermittent welding, a careful check must be made to see that the spacing and lay-out has been properly done and is in accordance with the design plans. Third, a visual inspection must be constantly maintained for proper technique during welding and for appearance of the weld after completion of the welding. In following the individual welder's technique, the inspector is concerned with the proper machine setting, direction and length of arc, the rate of consumption of rod—that is whether it is smooth or jerky, the size, shape and apparent fusion of the bead, and the sound of the arc. While these items are usually the responsibility of the contractor and his welding department supervisors, the inspector should make checks of these items, especially where any doubt exists as to the ability of any welder to properly deposit weld metal. After the welding has been completed it should be checked for physical appearance including evidence of slag and gas inclusions indicating porosity possibly due to failure to properly clean between beads; under-cutting; excessive spatter; overlapping or rolling of the bead; size of the crown; amount of convexity or concavity of fillets; equality of the two legs of the fillets; cleaning and painting of welds and peening—which, except in specific cases, should be done only on multiple bead welds and in no case should peening be done on the first and last beads. In addition to the above the Inspector must see that back-chipping is properly done to clean metal before the roots of welds are welded. He must see that no welding is done in temperatures below 10° F. unless adequate preheating is done and must check for and supervise any preheating or postheating which is required. He must see that the welding and repairing of castings is accomplished in accordance with General Specifications and that the proper preheating of castings is done in consideration of the carbon content and alloying elements present.

F. Post-Welding Tests

The sixth function in the inspection of welding involves post-welding tests of the welds and welded structures. There are a number of means of conducting non-destructive tests, some of which are more adaptable to certain phases of structural welding than others. Among them are:

The Magnaflux Method takes advantage of the principle that the magnetic reluctance of a ferrous metal increases in way of imperfections and hence a magnetic field passing through the weld at right angles to the direction of welding will manifest this by the appearance of small poles in a field of iron filings or by changes in field strength which may be detected by means of a sensitive meter carefully passed through the field. The magnetic field is usually contrived by passing fairly heavy currents (about 700 amp.) through the welded material. This process is quite adaptable to shop testing of welds and is extensively used in the testing of welds in high-pressure piping. It is not adaptable to the inspection of welds in a large structure such as a ship on the building ways.

The X-ray or Gamma Ray Method is probably the best means of conducting a non-destructive test. It consists of the passing of X-rays or Gamma Rays through the material to be inspected which impinge upon a

photographic negative and allow a picture to be taken of the material being examined in which imperfections may be seen and their position determined. This method is not used to any great extent in shipbuilding field welding inspection due to the expense, size and extent of equipment necessary.

The only post-welding non-destructive tests that *are* extensively employed in shipbuilding are the Strength and Tightness Tests which are conducted on tanks and compartments, to determine, as the name of the test implies, that water tightness exists and that adequate strength is present. The test-head for Hydrostatic tests of compartments and tanks is usually above the uppermost water-tight complete strength deck. This is above the "margin line" which is an imaginary line to which the vessel may be immersed without foundering, but beyond which immersion will cause loss of the vessel. These tests may be conducted using either water or air, although in the case of tanks which are to contain a liquid the test is always conducted with water. Hydrostatic tests are also prescribed for piping systems and for small non-structural tanks.

G. Conclusion

The foregoing is an attempt to cover as briefly and yet as completely as possible the scope of operations, pertaining to welding, included in the duties of an inspector of shipbuilding for the Coast Guard. Any of you who have been intimately concerned with such inspectors probably have some very real impressions and opinions concerning those individuals. Inspectors are seldom the most popular people in an industrial plant and this is certainly true of ship yards as far as my experience is concerned. However, it should be remembered in all fairness to the inspector that in his official capacity he is not acting as an individual but as a representative of another and higher authority and that he is governed by extremely definite and inflexible requirements and specifications, the responsibility for diversion from which he takes entirely upon himself whenever he fails to reject an item which does not comply.

The inspector can and should be an advisor to the contractor. He should be able to render assistance of inestimable value especially to inexperienced contractors who are not familiar with the detailed requirements of Government work. This is particularly true in ship building where there is such a vast difference between the type of work which is being accomplished on commercial vessels and that which is involved in the construction of Naval vessels. All together too often, however, the inspector is regarded as a sort of policeman who has been assigned to the job merely to reject work and to cause the contractor to use considerable time, energy and expense in the correction of the rejected items which in a great many cases are felt to be rejected without merit.

Pity the poor inspector—his is a thankless and onerous task. He is truly between the "Devil and the Deep Blue Sea," for if he rejects faulty material, he incurs the displeasure and wrath of the contractor; if, on the other hand, he *fails* to reject, he has certainly failed in the performance of his duty and his leniency will undoubtedly become a boomerang! There is but one safe course—he must let, not his conscience, but the plans and specifications be his guide and do his duty to the utmost of his ability.

Let it be remembered, however, that all of the detail and tedium outlined in this paper are but steps in the accomplishment of the two-fold mission of an inspector of shipbuilding: First, to obtain a properly constructed sea-worthy vessel built in accordance with the approved plans and meeting all applicable specifications, and second, to expedite its construction and delivery to the best of his ability.

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The Theory and Use of Specifications to Expedite and Control Production*

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I BELIEVE that a review of the things essential to the proper preparation and use of specifications is extremely timely because we have just completed a tremendous job of specification writing for the change-over from peace to war production and have now, for the first time, had some opportunity to review our work to determine which parts of it were good and which parts of it needed major or minor revision. We all know that sometime—we hope in the near future—we will have a reconversion job to do, and that many new materials and methods will be available, not only for changes in previous products but also for new products not previously commercially available. These materials and methods can only be properly used as the specifications for them are prepared and as those specifications are properly placed in the design of finished products.

There are three principal types of specifications, as I see them:

1. The project specification, which covers a completed article, including all of its component parts. This may range from a battleship to such a small unit as an automobile or a refrigerator. It must be supported by blueprints, design specifications and material specifications.
2. The product specification, covering a completed sub-assembly of the whole, which might be—in the case of a battleship—an electric generator or a gun or any other component piece of equipment.
3. The material specifications, covering a material or a single assembly or part, which are the initial step from which the project and product specifications are built up.

I propose in my discussion to deal primarily with the material specification, although I believe that the same line of reasoning will be, on the whole, applicable to the two other types of specifications.

The proper theory of a specification is that it be a concise, explicit, written statement of the consumer's requirements so that they may be thoroughly and completely understood by the producer's engineers. Such a document not only provides a means of procurement of the exact material wanted but provides the designer with a material or a part which he can use without further consideration as to its adequacy. This use of specifications permits standardization which allows interchangeability of parts with adequate provision for replacements, provides for adequate performance or strength characteristics and also provides adequate inspection to insure that the articles received will meet the minimum performance characteristics for the part or material required.

This country has a long experience in using specifications which through evolution have gradually become more clear cut and definite. I believe it was only the proper use of such specifications that has permitted the rapid expansion of our war-time production and the change-over of huge industrial plants to the manufacture of entirely new products. It has also permitted the rapid adoption of new materials which have been developed during this emergency period, either as substitutes for materials no longer available or as component parts of new articles previously not known or not needed. I believe that this successful use was only possible due to the fact that several of our organizations, of which A.S.T.M. has been the most active, have worked for over a hundred years on the preparation and standardization of specifications. However, our Naval experience has almost that long a continuous history and I would like to review briefly some of the things which we have done in order to show that the Navy is entitled to some opinions as to how specifications should be prepared and used.

In May 1868, the Navy Department issued the standard gage for bolts, nuts and screw threads which was, I believe, the first standard for this material in the country. More recently, I'd like to refer to our specification for electrical measuring instruments, initiated in 1915, revised on the basis of performance in 1925, and in 1930, presented to the International Electro-Technical Commission and offered as a contribution of the U. S. National Committee for world standardization. Still more recently, I would refer to our radiographic standards with which many of you are familiar. These last standards do not cover all the possibilities and may not adequately cover the technique of preparation of radiographic pictures. However, they are, to my knowledge, the most complete and adequate standards currently available. Many other examples could be cited. However, I think this is adequate to show that the Navy has a very long and continuous history of dealing with specification requirements and of establishing definite standards.

The Navy's purpose in the preparation of a specification is to define exactly what is wanted. The primary approach to this job insofar as practicable has been and will continue to be on the basis of required performance. In other words, we endeavor to inform the manufacturer of what we need and what the article or material is to do rather than to tell him how to make it or what to make it from. By the preparation of specifications in this manner, it leaves a very considerable initiative in the hands of the manufacturer to develop materials particularly suited to his equipment and to develop new techniques of manufacture to provide adequately the articles which will serve the purpose intended and to make changes in design which do not affect the ultimate use of the article. This permits the engineering staff of the manufacturer to constantly and aggressively tackle the problem of improvement in our material or of reduction in cost by more expeditious methods of manufacture, and has proved of immense benefit to us, in this case the consumer, since many of the advances and revisions of specifications have be-

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come practicable due to improvements found by manufacturers independently of any guidance from the Navy. Unfortunately, not all specifications can be written in this manner as, in certain instances, past experience has shown that material from which parts are made must be within certain definite classes or chemical limits, or has shown that certain types of materials may not be used. Where a sufficient background of experience exists it is, therefore, necessary to insure against delays in delivery from our viewpoint and, to protect the manufacturer from wasting time and material manufacturing products which will ultimately be rejected, to specify things which may not be done, or materials which may not be used. Occasionally, even a fixed design or a method of manufacture may have to be prescribed. This is extremely disadvantageous both to the producer and to ourselves as it freezes the engineering skill and ability of our engineers and slows down or completely stops progress. It also excludes from the procurement field material or equipment which does not rigidly follow the pattern and, therefore, in the case of rapidly expanding demand, such as we have recently experienced, would require the erection of new plants or the installation of new and different machinery in existing plants rather than to permit a conversion job using all practical existing equipment.

The Navy has long recognized and lent every emphasis to the importance of specifications and the necessity for uniform methods in the preparation and expression of requirements in order that the full objectives of its procurement in time of war could be realized, both as to quality and to quantity. It is largely because this was so long ago realized and worked out in such detail both in administrative organization and in technical requirements that procurement for and by the Navy has been fairly successful despite the many difficulties introduced by the rapid expansion of requirements and the shortage of many critical materials.

In using the preferred performance type of specification it is necessary not only to state the use to which the article or material will be placed but to provide definitely for the physical requirements, such as strength, finish, endurance, corrosion resistance, resistance to flammability and any functional requirements relative to size, shape or weight, but to write also specific tests and test methods into the specification to insure that the various requirements have been met. Before dealing with these test methods I would like to state here that it has been the Navy's practice, and is believed to be the only satisfactory practice, to make the requirements for these various qualities the minimum satisfactory values and not to insist on obtaining the most perfect or the best if these qualities are not essential. In attempting to set these requirements at the minimum satisfactory standards, frequent revision is necessary either as production standards throughout the country permit a raising of the minimum requirements to produce a better end product, or because a lowering of the standards is possible on account of improvements in design or in other parts, and also as service experience indicates, through failure or non-failure of the material or parts, that the specifications are too rigid or inadequate.

The standards set have, to some suppliers, appeared extremely high. However, they have been based on actual service experience or on collateral experience from similar material previously used, and it has been believed that their maintenance at the level set has been absolutely necessary. It is easy to see in the case of a ship or an airplane operating independently and at a distance from any repair facilities that the failure of any part may cause a major portion of her machinery to become inoperative. This in turn may cause the loss of the plane or vessel and thus have a disastrous military effect upon the operation on which she is engaged or possibly even upon the ultimate outcome of the war.

The Industrial Test Laboratory at Philadelphia, of which I have been in charge during the present emergency period, is one of a system of Naval laboratories used not only as a part of the inspection system to determine accurately composition, strength, flammability and other qualities of materials submitted by the Inspectors of Naval Material but also to develop test methods for new and substitute materials to be incorporated in specifications for these materials. At the Philadelphia Laboratory we have, during 1943, developed the technical details and requirements for 27 new specifications and for the major revision of 19 specifications. This, of course, is not nearly as large a number as were of necessity developed in the two preceding years. However, I believe it indicates adequate experience with this type of work to justify describing the steps necessary to such definition of detailed requirements, tests and test methods as will prove the material delivered is the material desired.

The development of the technical requirements for BuShips Specification 24C40-(INT) for Canvas, Fire, Water and Weather Resistant, is a reasonably typical example, and I will therefore describe the steps involved in its development.

Naval action in Europe showed that the conditions of warfare had sufficiently changed to make the hazard of fire much more serious than it had previously been evaluated, as ships were lost due to fires in action when the direct material damage was relatively minor. The Bureau of Ships, therefore, before our entry into the war, started a major program of developing fireproof or fire retardant materials to replace the many flammable items used aboard ship. The problem of developing such treatments for canvas was assigned to Philadelphia.

An immediate search of literature on such treatments and a review of existing specifications for similar material was made. This is considered to be a necessary first step in all such investigations as it is extremely desirable to use any adequate existing specification rather than to originate a new specification which manufacturers must carefully study to insure suitability of their product.

In this case the search revealed a Federal specification for similar material. Careful study of this specification in comparison to the product of the one previously approved exhibitor whose material was known to be satisfactory in service, as well as on the basis of test performance, revealed that the Federal specification did not adequately define material which would give satisfactory service under the severe conditions encountered at sea. However, it did provide test methods and terminology with which the textile coating industry was familiar.

The primary consideration in the preparation of any specification, as indicated previously, should be to define exactly what is wanted. Before any such definition is possible, however, the essential differences between acceptable and non-acceptable material must be recognized, and suitable tests to demonstrate these differences must be developed. In this case, the proprietary treatment gave satisfactory service, and thus represented acceptable material. Non-acceptable material, however, was less readily defined. Obviously, the most satisfactory method of differentiating would have been to secure samples from all possible suppliers of treated canvas, and to expose these to service conditions for an extended period, selecting those suitable for use on the basis of actual performance. Equally obviously, procurement of material urgently needed could not be delayed for the time necessary for this procedure.

The only possible course, therefore, appeared to be the one adopted. Samples were obtained from a large number of suppliers, and these were compared, on the basis of laboratory tests, with the material previously found acceptable. However, samples of the products were, at the same time, placed on outdoor exposure racks in order that results might be available to check those of the laboratory tests at a future date.

The test methods by which the submitted samples were to be evaluated were the objects of the initial work. The Federal specification for Fire, Water, and Weather Resistant Duck was already familiar to the industry, and its test methods were in common use. These methods, therefore, were first tried and, wherever possible, were adopted. Most of these were, fortunately, found suitable with or without minor changes. Some, however, needed major modification, in particular those which were intended to evaluate the durability of the treated canvas when exposed to severe weather conditions, such as are encountered by the Navy, and some additional tests were added to more adequately measure this property.

Consideration of the formulation of the one known acceptable product in the light of the then existing world conditions indicated that one of the principal components might become unavailable at any time and, therefore, made it mandatory that this specification be of the purely performance type to permit substitution made necessary by the unavailability of ingredient materials at any time. However, as the test work developed it showed that a fairly long period of exposure in even the most accelerated test equipment commonly available was necessary to differentiate satisfactory and unsatisfactory material. The delay in shipment that would have been caused by sufficient testing of each lot from production to insure satisfactory material would have caused too great a delay in procurement, and it was therefore necessary to establish an approved list under the specification by which a treater was qualified to provide material processed by his equipment using a specific formulation and to limit inspection testing to identification tests to compare the product submitted for delivery with that approved.

This left the manufacturer free to qualify different compounds and treatments as availability of raw materials varied and still provided the Navy with the quality and quantity required with a minimum delay in deliveries.

During this development period frequent conferences were held with manufacturers' technicians as to methods of application practicable with their existing equipment when using substitute formulations, and through the Bureau of Ships close contact was maintained with the W.P.B. as to current and prospective availability of critical materials.

The data obtained, together with a full description of the test methods developed and recommendations as to the establishment of the standards to be required were forwarded to the Bureau of Ships. The Bureau reviewed the data and upon approving it prepared and issued a specification for the material. The actual preparation and issue of specifications is centralized by the Navy to provide for standardization and to prevent duplication.

The specification as first issued set standards somewhat lower than the present requirements, but continued in effect for eight months without major change. As the use of the specification developed, however, we acquired a considerable background of experience, augmented by the results of a large number of service type exposures, and it became practicable, not only through better manufacturing control, but also through development of additional materials and a slight relaxation in availability of materials to raise the standards required more nearly to those originally desired. The current revision of the specification was thus issued on August 15, 1943, and an additional test was incorporated to better insure the durability of the processing when exposed to severe weather conditions.

Manufacturers have been able to develop new formulations and to improve their application techniques operating under this plan to such an extent that it should soon be possible to raise the minimum standards to a point which will give much more adequate protection from fire hazards.

The specification chosen did not require the use of any particular new development in instruments. However, in conjunction with the establishment of satisfactory color standards the spectrophotometer was used in the hope that color could be expressed in numerical values sufficiently definite that manufacturers using other and less expensive types of machines, such as the Hunter Reflectometer and abridged spectrophotometers might be able to satisfactorily control production so as to insure staying within the prescribed color range, which, because much of this material would be used on the exterior of the ship, was important as camouflage. Due to certain inherent difficulties of measurement, such as the fluorescence of some materials, and to a lack of agreement as to the effect of various factors such as gloss, it was found impracticable to make such definition at this time and color had to be controlled by the use of visual comparison in a "clear north light," which has always been the subject of many arguments and endless discussions. I am mentioning this solely as an example of the fact that although instruments are continuously becoming available before results obtained from them can be used as specification requirements, I believe that research and development organizations should continue their use in attempts to establish such definite numerical standards so that eventually the characteristics required can be removed from the field of judgment into numerical evaluations by standard methods. However, in such development work the specification writer must constantly keep in mind, in case of expensive instruments, that it is also necessary to have a moderately priced and available machine which will give similar results in the range required so that the manufacturer can be expected to purchase and install one for his own guidance before such requirements can be made mandatory, and therefore, that whenever it appears that the use of absolute evaluations may become practicable a development of moderately priced instruments in the ranges to be specified should be encouraged. In the case of the General Electric Hardy Spectrophotometer with an integrating sphere designed to eliminate gloss effect, for some purposes several instruments give promise of meeting this requirement: Snow-Duplex Spectrophotometer, Hunter Reflectometer, Beckman Spectrophotometer, Coleman Spectrophotometer, Cenco Spectrophotometer. One of these, the Snow-Duplex Spectrophotometer, which simultaneously projects onto the same opaque screen two curves showing the colors of a given material and its standard, gives promise of becoming a production control instrument.

Obviously, many considerations necessary to the preparation of specifications of maximum utility cannot be covered in such a short talk. However, a few of these I would like to mention. Experience has shown conclusively that specifications must be kept to the minimum length practicable for adequate description of the material desired and clear definition of the test methods and standards to be attained. This is, to a great extent, accomplished by the A.S.T.M. and by the

Navy by placing details of test methods in separate manuals and only referring to them in the specification as such a test, giving adequate reference, and in Naval specifications by the placing of contractual information, when necessary, in notes which need only be considered by the procurement officers and sales forces.

The proper preparation and use of specifications expedites production by permitting parts to be manufactured either in the contractors' plants or by subcontractors without any consideration as to their ultimate effective use, provided they meet the standards of the specification. This broadens the procurement base and, therefore, permits rapid changes in the quantities required, while at the same time, insuring the quality of the part and its adequacy for use in design.

The test methods and standards written into the details of the specification provide the manufacturer with a ready-made inspection system for his own production line, and therefore, provide a ready means of control which should prevent the manufacture of any large quantity of unusable material. To accomplish this the test methods must be clearly stated, must be of such a nature as to be performed on equipment available to or ordinarily owned by the suppliers, and must set standards of performance definitely measurable and not subject to the judgment of the operator.

I believe that this group, in the change over to peacetime production, has a tremendously important function to perform in connection with the preparation of specifications. All of us are undoubtedly of the opinion that welding will be increasingly used in fabrication after the war and that, therefore, many specifications requiring it will have to be issued. There is, at present, a tendency to require in the specifications for base material, particularly steel plate or castings, that it be "of a weldable grade". We all know that practically any steel can be welded under the proper conditions. Therefore, the expression "of a weldable grade" is, in effect, meaningless. Each of you, therefore, should encourage the specification writers in your own organizations to make a definite statement, either insuring by chemical composition limitation that the material will actually be of a weldable grade, or in case that is impracticable, to define the condition of the weld as to type of welding, temperature, current and voltage if electric welding, condition of the test specimen as regards restraint and whether or not pre or post heat is to be used. Specifications so drawn should provide material with which subsequent difficulties will not be encountered; whereas, the loosely stated specification requiring material to be "of a weldable grade" may or may not serve its purpose.

You also have a major task in cooperating with the design groups in your own organizations. You have all heard of a number of failures charged to welding, particularly in heavy structures with large, locked-up residual stresses. Many of these could undoubtedly have been avoided by a change in design, particularly if that change of design were accompanied on the blueprints by a tabulation of welding sequence so as to leave in the major assembly the minimum amount of residual stresses locked up in the final joints. Further, the tolerance of the fit of the various joints should also be prescribed for the introduction of an extremely heavy weld to make up for the deficiency of poor cut out and fit up work is, in itself, an inherent danger.

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(*Continued from page 528*)

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"Arc Flash" Conjunctivitis*

By Forrest E. Rieke, M.D.†

WHEN the war came to Portland, Ore., early in 1941, it brought with it a host of problems new to the medical profession of this community. The establishment of three major Kaiser shipyards and several other smaller Navy contract shipyards in the heart of the lumbering area could not do otherwise. Prior to 1941 the chief industries in Oregon and southern Washington were lumbering, fishing and agriculture, and their importance has continued.

At the same time, in the past 21 mo. approximately 85,000 men and 25,000 women have left their regular pursuits and turned to employment in steel shipbuilding. It is safe to say that 80 to 90% of this group are now occupied in work foreign to their previous employment in strenuousness, speed, hours and location.

New Problems for Employees and Physicians

Steel shipbuilding now ranks ahead of all other industries in this area, and the problems which it introduces in health and industrial hygiene are new to the employees and their physicians. In protecting the health of these employees it has been and continues to be extremely important, therefore, that both the workers and their physicians receive the fullest possible instruction in shipyard hygiene, health hazards and safety practices.

Because the Oregon Shipbuilding Corporation has been one of the foremost shipyards in rate of production of liberty freighters in the United States and the training ground for a major share of the workers of all the shipyards in this community, because Portland has shared equally with the nation in doctor shortages and because our local doctors have been too busy to do postgraduate study with experienced industrial physicians, we have had to find the answers to many of our medical problems in the school of experience. This has been true in many fields, and particularly is this true in the case of electric arc welding as applied to eye injuries.

Eye Complaints Rank High

For the first six months, 40% of the treatments administered in the shipyard dispensary were for eye complaints. With better workman training and adequate eye protective devices this percentage has gradually dropped, but it still remains above 30% of all treatments, which have totaled over 650,000 in 25 mo. In the first year of production, the supply of goggles and other safety equipment was constantly inadequate to cover our rapidly increasing number of employees. Many hundreds of eye injuries that were then seen were preventable and have since been prevented.

Inherent in steel work is a potentially high incidence of eye trouble, and certain recent changes in fabrication methods have increased the dangers of eye injury. I have reference to one of the most outstanding changes from the last war, namely, electric arc welding. A multitude of uses have been found for welding not previously employed.

Oregon Shipbuilding Corp., alone, now employs 3800 male and 1650 female welders. Welding is done in every part of the yard, and therefore, at least 25,000 of the 33,000 employees are exposed to possible eye injury through radiation and other hazards found in this process.

"Arc flash" eye injury is important and frequent with these persons, and the information given here concerning the recognition and treatment of the condition is recorded with the hope that it may prove useful to the physicians and safety personnel of this and other war production communities.

Nature of the Injury

Actinic or ultraviolet conjunctivitis bears the unfortunate name of "arc flash" and may be defined as a conjunctivitis or inflammation of the whites of the eyes, usually of both eyes, caused by excessive exposure to the welder's electric arc and characterized by delayed onset, self-limited course of 24 hr., pronounced bulbar hyperemia or redness of the whites of the eyes, swelling of the lids, slight "sunburn" of the face, absence of discharge other than tears, extreme photophobia or sensitiveness to light and a feeling of sand in the eyes.

The name "flash" is heavy with the implication that this eye injury is commonly incurred through an incautious or unguarded exposure of the eyes to the flash of the welder's first brilliant contact spark and thus is an instantaneous affair. This can occur, but the injured person must be very close to the arc, within a foot or two, and this proves infrequently the case. It is so usual as to be the rule that the painful eyes of "arc flash" result from an excessive exposure to the arc over a minimum of several minutes, more commonly several hours of time spread through the working shift. It is a cumulative injury similar in pathogenesis to that of snow blindness and sunburn, which obviously are quantitatively related to skin pigmentation and length of time spent in the sun's rays. For this reason, it has been necessary, occasionally, to change the location of work for certain very blond or red-haired workers from shops in which they were constantly bombarded by ultraviolet radiation from nearby welding operations. The oxyacetylene torch does not commonly cause "arc flash."

At Oregon Shipbuilding Corp. we saw several hundred cases of true radiation conjunctivitis during the first year, most frequently among our new employees. During our second year, with a much larger payroll and two to three times as great a rate of ship production we have seen relatively little of the arc flash "red eyes."

At Kaiser Co., Inc. Portland, currently in the first year of production, with 27,000 employees and a large number of men and women new to the work, history is repeating itself and a far higher percentage of "arc flash" injury is occurring than at Oregon Shipbuilding Corp.

* Presented at the National Safety Council's 32nd Annual Safety Congress. Similar to an article published by the author in the July 10, 1943 issue of the Journal of the American Medical Association.

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Statistics on Arc Flash Eye Injuries

Accurate figures on the incidence of arc flash eye injury are impossible to secure for various reasons. Purely for the sake of the record, the figures are included and their heading is self explanatory. They must be taken with certain reservations and are more interesting than conclusive.

The figures represent workmen who filed reports of accident with the State Industrial Accident Commission. In the "no time loss" cases either only part of the day of injury was lost or a claim was filed so that the state would reimburse the attending ophthalmologist. Any workman losing time other than the day of injury is considered to have suffered a "time loss" accident. These figures are, of course, low, for a large proportion of flash injured workmen have treated themselves at home or have been treated in the first aid units at the shipyards without time loss, in which case no state claim has been filed. Many others have not bothered to file a claim for a day of time loss, so they do not appear in the "arc flash" records.

Unfortunately, a number of the cases in this group represent questionable diagnoses, even though reported to the State Industrial Accident Commission as "arc flash." Until July 1, 1943, there was no occupational disease law in Oregon. "Arc flash" was accepted by the State Industrial Accident Commission as a compensable "accident." As a result, physicians when in doubt as to the exact diagnosis have not infrequently accepted the workman's theory and have listed a nonspecific conjunctivitis as an (alleged) "arc flash."

Table 1—Figures on Arc Flash and Foreign Body Cases

Oregon Shipbuilding Corp., Period of June 1941 to July 1943

Date	Injury	Total	Non-Time Loss	Time Loss	Days Lost	Av. Day's Loss per Time Loss Case	Av. Monthly Payroll
June 1941	A.F.	4	4				
	F.B.	7	5	2	2	1	
July 1941	A.F.	4	1	3	6	2	2,500
	F.B.	13	12	1	16	16	
Aug. 1941	A.F.	16	10	6	7	1.17	5,300
	F.B.	22	13	9	45	5	
Sept. 1941	A.F.	21	7	14	18	1.28	7,100
	F.B.	25	13	12	45	3.75	
Oct. 1941	A.F.	27	13	14	50½	3.61	9,800
	F.B.	33	17	16	101	6.31	
Nov. 1941	A.F.	30	21	9	23¼	2.58	12,200
	F.B.	45	31	14	41	2.93	
Dec. 1941	A.F.	22	6	16	31	1.94	14,600
	F.B.	25	9	16	49	3.06	
Jan. 1942	A.F.	60	28	32	91	2.84	17,100
	F.B.	94	49	45	113½	2.52	
Feb. 1942	A.F.	31	12	19	39	2.05	22,600
	F.B.	71	43	28	121½	4.34	
Mar. 1942	A.F.	40	20	20	57	2.85	27,200
	F.B.	79	48	31	158½	5.11	
Apr. 1942	A.F.	59	35	24	54½	2.27	30,100
	F.B.	98	53	45	242½	5.39	
May 1942	A.F.	53	29	24	73½	3.06	30,800
	F.B.	116	65	51	2103	41.24	
June 1942	A.F.	56	26	30	66½	2.22	30,000
	F.B.	101	50	51	335	6.57	
July 1942	A.F.	51	23	28	73	2.61	32,400
	F.B.	114	76	38	183	4.82	
Aug. 1942	A.F.	54	28	26	63½	2.44	34,900
	F.B.	216	142	74	232	3.14	
Sept. 1942	A.F.	92	55	37	56	1.51	34,200
	F.B.	417	258	159	338	2.13	
Oct. 1942	A.F.	76	44	32	78	2.44	32,900
	F.B.	394	245	149	428	2.87	
Nov. 1942	A.F.	57	36	21	42	2	33,100
	F.B.	359	218	141	286	2.03	
Dec. 1942	A.F.	77	45	32	111	3.47	33,600
	F.B.	309	173	136	342	2.51	
Jan. 1943	A.F.	79	32	47	174	3.70	33,800
	F.B.	269	134	135	1480	10.97	
Feb. 1943	A.F.	76	37	39	118	3.03	34,800
	F.B.	267	155	112	445	3.98	
Mar. 1943	A.F.	92	43	49	192	3.92	33,500
	F.B.	281	172	109	256	2.35	
Apr. 1943	A.F.	80	34	46	158	3.43	33,500
	F.B.	277	185	92	182	1.98	
May 1943	A.F.	54	30	24	51	2.13	33,200
	F.B.	269	150	119	306	2.57	
June 1943	A.F.	68	34	34	115	3.38	33,400
	F.B.	269	118	151	520	3.44	
July 1943	A.F.	60	28	32	74	2.31	34,200
	F.B.	348	186	162	411	2.54	

A Typical Case

In order that you may secure a clear understanding of the nature of "arc flash" injury let me describe a "typical case." The workman leaves the job in a healthy condition and is entirely unaware that he has received eye injury until he has been at home for several hours. The day shift man usually wakens at midnight or later with the painful, sandy, swollen eyes described in the definition. One rarely sees the condition develop in the injured person during the shift in which he has received the ultraviolet "overdose," although, on occasion, one will see a new workman who received a very heavy irradiation early in the shift and begins to feel pain and develop redness toward the end of the shift.

This latent period between injury and onset of symptoms is undeviating except in fuse box explosions and the like, a point emphasized in personal communications by Dr. Hedwig S. Kuhn. The strongest confirmatory point that "arc flash" is not due to the single bright flash but rather to an accumulated excessive exposure is the fact that, almost without exception, the injured workman is caught by surprise in the middle of the night, as aforementioned, having been entirely unaware at the time of injury that he was receiving trauma sufficient to elicit a delayed inflammatory response.

Table 2—Figures on Arc Flash and Foreign Body Cases

Kaiser Co., Inc., Portland, Period of June 1942 to July 1943

Date	Injury	Total	Non-Time Loss	Time Loss	Days Lost	Av. Days Loss per Time Loss Case	Monthly Av. Payroll
June 1942	A.F.	4	1	3	6	2	3,353
	F.B.	3	7	1	2	2	
July 1942	A.F.	6	4	2	6	3	4,647
	F.B.	6	2	4	9	2.25	
Aug. 1942	A.F.	2	1	1	2	2	6,757
	F.B.	8	5	3	7	2.33	
Sept. 1942	A.F.	8	3	5	19	3.8	9,597
	F.B.	34	16	18	48	2.67	
Oct. 1942	A.F.	20	11	9	18	2	13,782
	F.B.	31	14	17	36	2.12	
Nov. 1942	A.F.	23	8	15	36	2.4	16,215
	F.B.	49	19	30	94	3.13	
Dec. 1942	A.F.	35	14	21	54	2.57	16,430
	F.B.	62	31	31	75	2.42	
Jan. 1943	A.F.	31	15	16	40	2.5	18,711
	F.B.	48	19	29	97	3.34	
Feb. 1943	A.F.	35	15	20	70	3.5	20,961
	F.B.	63	27	36	177	4.92	
Mar. 1943	A.F.	39	20	19	64	3.05	17,260
	F.B.	52	31	21	77	3.19	
Apr. 1943	A.F.	22	8	14	33	2.36	17,452
	F.B.	40	21	19	73	3.84	
May 1943	A.F.	34	12	22	103	4.68	24,000
	F.B.	44	27	17	50	2.94	
June 1943	A.F.	35	18	17	54	3.18	25,200
	F.B.	69	31	38	111	2.92	
July 1943	A.F.	35	16	19	42	2.21	26,500
	F.B.	56	27	29	103	3.55	

It is commonplace for workmen to enter our "eye treatment" room in the shipyard medical unit seeking treatment for "arc flash." Examination reveals normal eyes, and further questioning brings out some such story as this: "I have no pain, but I was working near a welder a few minutes ago when he struck an arc. I'm sure I was flashed, so I want some of that medicine put in my eyes which you use to prevent arc flash trouble." Most of the workmen believe staunchly that we have such a medicine.

The misconception has arisen through a lack of understanding of the pathogenesis of radiation conjunctivitis. The workman who thinks he has received a "flash" injury through exposure to a bright flash, receives treatment of any sort immediately afterward, and develops no symptoms, naturally assumes that this treatment has been prophylactic. In actuality, he has had no injury. This occurs many times daily, and over months of time the shipyard employees have come to believe this obvious

fallacy. As a result, our records are misleading and we have for some months attempted to keep a record of alleged arc flash as opposed to real, clinical flash with red, painful eyes.

Confusion from Records

The confusion in our records on alleged and real, clinical arc flash has caused much trouble in that any workman who develops eye trouble for any one of a number of reasons tends to put the blame for the pathologic condition on some previous alleged arc flash, and he will find corroboration in our recorded, inaccurate diagnosis. Close questioning here almost invariably reveals that the workman has reference to some bright flash, sine subsequent symptoms, experienced days or weeks before. One sees here again the age-old practice of seeking an obvious cause for a disease process often far removed from the real cause.

The misconception exists that "arc flash" injury is more apt to occur at night. We have not found this to be the case. After dusk the workman's green tinted protective goggles are put aside because of interference with vision in the semidarkness prevailing under coastal "dimout" conditions. The probable increased exposure to "arc" thus engendered is usually minimized because of the increased perceptibility of the welder's arc with consequent exercise of greater caution by those exposed.

The relative infrequency of "arc flash" injury to one eye is emphasized. If a workman with inadequate protection has held material being welded for several minutes to hours and thereby received heavy radiation to one side of his face, he will display a unilateral sunburn and "flash" injury of the eye on the exposed side. We observe a hard and fast rule that a workman with one inflammed eye does not have an "arc flash" injury until foreign body injury or other types of conjunctivitis have been ruled out by diligent examination.

The pathologic changes of "arc flash" conjunctivitis are confined to the superficial structures of the eye. The slit lamp reveals some superficial epithelial devitalization and minute edematous blebs on and in the epithelium of the cornea which is quickly repaired within 12 to 18 hr. after onset of symptoms. The cornea, iris and lens absorb the utraviolet rays and prevent penetration, thereby protecting the deeper structures of the eye. We have found no evidence that this temporary injury to the corneal epithelium either permits ready bacterial invasion or contributes to permanent injury of the cornea, even though frequently repeated.

To return to the discussion of the typical case, we find that "arc flash" conjunctivitis is self limited, that the photophobia and pain last from 12 to 18 hr. from the time of onset and that some workmen lose no time, while the severely affected person needs miss, at the most, only one shift. Many men will lay off for several days, but this absenteeism cannot legitimately be attributed to real flash injury.

Apropos of this matter of unduly prolonged time loss for "arc flash," one may note in Table 1 the definite trend toward increase of average days lost from "arc flash" injury from 1.17 days in March 1943, a change which can be laid only to errors of diagnosis and wilful absenteeism. On the other hand, in the first year of our operation, when "arc flash" was quite common, I found that our men displayed fortitude of great degree, remaining on the job with very painful, red eyes against my strongest advice, motivated largely in this obstinacy by the bonanza wages. It has not been my custom to try to dictate to the workman who presents himself for care of a definite arc flash whether he shall leave the job or remain, unless he chooses to ignore his personal safety. The degree of photophobia (sensitiveness to light) and pain usually has determined his willingness to work or go home.

Treatment

Because of the fleeting nature of this injury and its affection of the superficial structures, our treatment is directed toward symptomatic relief of local pain, redness and heat, iris spasm and photophobia. The "sandy" pain is of such degree that general sedation is frequently indicated. The various agents employed are:

1. A darkened room or dark glasses.
2. Cold applications to the eyes.
3. A local anesthetic applied to the eyes; in watery solution while on the job and for immediate relief, in ointment base at night while attempting to sleep. The following are suggested: in water, pontocaine, butyn; in ointment, holocaine, metycaine, butyn.
4. A vasoconstricting drug such as ephedrine or epinephrine.
5. Occasionally, 1% homatropine to relieve iris spasm in severe cases.
6. A lubricant to relieve corneal drying—castor oil or lubricant base anesthetic.
7. Analgesics and sedatives in the very severe cases.

It has been recommended that the patient be treated for arc flash by gazing into an infrared lamp for 1 to 2 min. I have been afraid to use this method and see no reason why it should be either safe or beneficial.

Shipyard Program

Our shipyard program to control this malady has been directed along several main channels:

1. Protective devices have been employed: "calobar" type flash goggles with side guards, helmets, welding clothing, screens, surrounding the welder at work.
2. Hazards have been explained through training classes, newspaper articles, labor union news sheet, shipyard magazine, safety pamphlets and the like, and instruction in the methods of protection has been widely disseminated.
3. Ophthalmologists have been brought to the shipyards to instruct medical personnel in the diagnosis and care of eye injuries and diseases. They have also discussed the same problems in medical society meetings.

The most effective educational agent of all in the abolishment of "arc flash" injury has been a personal experience by the individual workman with the exquisitely scratchy pain of the full fledged conjunctivitis. The repeaters are few and they usually have been caught off guard.

Summary

1. Actinic conjunctivitis, or "arc flash," as seen in the Oregon Shipbuilding Corp. and the Kaiser Co., Inc., Portland, among 60,000 shipyard workers exposed at various times to the emanations from electric arc welding, is defined as a conjunctivitis caused by excessive exposure to the welder's electric arc and characterized by delayed onset, self-limited course of 24 hr., pronounced bulbar hyperemia, swelling of the lids, slight "sunburn" of the face, absence of discharge other than tears, extreme photophobia and a feeling of sand in the eyes.

2. Treatment is given for relief of symptoms through dark glasses, cold applications and the use of local anes-

thetic, vasoconstricting, mydriatic, lubricating and sedative preparations.

3. Prophylactic measures are outlined for the patient and his environment which can completely prevent occurrence of the injury.

Bibliography

Verhoeft, F. H., and Bell, Louis, "The Pathological Effects of Radiation on the Eye," *Trans. Illum. Eng. Soc.*, 16, 625–665 (1921).

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Methods of Stress Relieving*

By W. E. Ryan†

IN recent months we have heard a great deal of talk about locked-up stresses due to welding. By following proper procedure we can usually keep stresses within allowable limits, but in some cases this cannot be done. So in these cases it is necessary to remove the stress after welding has been completed.

Stress in metal is nothing more than deformed grains. There are two kinds of deformation—elastic and plastic—which I shall explain briefly.

When metal is deformed elastically, if the strain is removed it will return to its original condition. But if the load is increased, a point is eventually reached where the metal reaches its elastic limit, and will not return completely to its original condition. At this point it has reached its yield point or plastic stage.

Plastic deformation is the point where the metal stretches or bends and stays in that condition. It is permanently deformed.

Most of the common metals have a cubic or square crystal. The angle between each face is the same unless it is deformed by some strain or force.

At ordinary temperature metal is rigid enough to hold these grains or crystals in a deformed condition almost indefinitely, because plastic flow is very slow in cold metal. In some cases yield point or the plastic stage and ultimate tensile strength are very near the same and in such cases breakage occurs. But in general the higher the temperature goes, the lower tensile strength and greater ductility may be expected. Strength and ductility are directly proportional to each other, when one is high the other is low.

Stress relieving is accomplished in four ways: cold peening; mechanical or hydrostatically, stressing the base metal slightly above the yield point or plastic deformation; stress relieving by heat; and full annealing. I shall discuss each method briefly.

Peening is often used but has some serious drawbacks. It is usually done when the metal has cooled enough so that the hand can be held on the metal without burning. All passes except first and last are peened with a blunt punch or rounded end of a chisel. The difficulty in this method is that there is no easy way of determining when the neutral point is reached. If overpeened a reverse stress is set up. There is almost sure to be some work hardening set up in this manner but it is largely removed by the heat of the succeeding passes and this is the reason for not peening the last pass.

In the case of fixed plates peening may correct the condition as far as the plates are concerned, but the weld itself may be in worse condition because the work hardening would reduce ductility. This is especially true where the last passes are peened or "bobbed" to a smooth surface. At any rate the base and weld metal are not all in the same condition.

Here I wish to call your attention to the fact that severely stressed metal is less resistant to corrosive conditions than unstressed metal.

Some research has been done; it is not thoroughly understood but some authorities believe it is caused by electrolysis. As an example, where brackets were welded on boilers after they had been stress relieved, a distinct outline could be seen inside.

In Europe it is a common practice to stress relieve pressure vessels with hydrostatic pressure. The strain is increased in this manner to slightly above the known yield point. Great care must be taken to prevent overstressing which would cause strain hardening. This method is limited because of mechanical difficulties. In the case of plates or beams it would be almost impossible.

Stress relieving by heat is the most common and most practical method. A furnace of sufficient size is needed depending on the size and type of item the particular plant is producing. It can be fired by gas or oil. It is customary to heat the weldment to a temperature of 1100 to 1250° F. It is considered a good practice to increase the temperature 300 to 400° per hour on complicated structures, to prevent overheating lighter members before heavier sections reach the same point. The 1100 to 1250° F. temperature should be held to the equivalent of one hour for each inch in thickness of the heaviest section. Cooling should be very slow in complicated structures, sometimes as long as 48 hr. Smaller items are often allowed to cool in still air. The more common practice is to cut the fire after the proper length of time and allow articles to cool in the furnace.

The fourth method is full annealing, and here I wish to explain briefly the physical changes which occur in this method that do not occur in stress relieving at 1100 to 1250° temperatures.

At about 1550° F. most of the common grades of steel become austenite, a technical term which means the metal is a solid solution. Each grain is identical. If austenite is cooled very rapidly a stage known as martensite is formed which is very hard and brittle. It may be said that martensite is frozen austenite because the various elements did not have time to separate.

If austenite is cooled very slowly, a stage known as pearlite is formed which is soft and ductile. In this condition the iron and carbon, which are unlike materials, have separated and each grain is not necessarily alike. Upon examination it would be found that some grains of practically pure iron, iron and carbon, and others of almost pure carbon would exist.

This explains the difference between the terms stress relieving and stress annealing. It is customary to increase the stress-annealing temperature 50° above the critical or austenitic range.

Procedure for supporting, heating and cooling are very similar to those already outlined for stress relieving.

* Pre ented at March Meeting, Mobile, Ala., Section, A.W.S.

† General Foreman, Welding Dept., Alabama Drydock & Shipbuilding Corp., Mobile, Ala.

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When Long Distance Says—

"Please limit your call to 5 minutes"

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BELL TELEPHONE SYSTEM

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

1939 VOLUMES JOURNAL NEEDED

The American Welding Society is badly in need of bound volumes of the 1939 Welding Journal. Any member desiring to dispose of same will receive $5.00. Alternatively the Society will be glad to pay 50 cents for copies of the January 1939 issue.

WELDING SOCIETY RESERVE FUND

The Board of Directors at their meeting on May 25th received the report of the Special Committee in charge of increasing the Reserve Fund of the Society by $85,000. The first letter sent out to Sustaining Companies and Members brought in well over $20,000. The Committee plans to continue its efforts until the $85,000 goal has been reached. Publication of the names of the contributing companies will be made in an early issue of The Welding Journal as a partial acknowledgment of the help thus received.

The purpose of increasing the Reserve Fund is to provide a sum equal to one year's operation of the Society. Without such a reserve, the Finance Committee each year would have to propose a more conservative budget and, therefore, a more restricted operation than would be necessary if this back-log of funds was available for emergencies.

WELDING BOOKS

Aircraft Torch Welding, by C. Von Borchers and A. Ciffrin, 1942 edition, Pitman Publishing Co., 157 pages. Price $1.25.

A textbook covering all phases of oxy-acetylene welding as applied to aircraft which presents the subject matter in a simple practical manner. The authors are eminently qualified to prepare this work through long association with the aircraft industry.

The whole range of the subject is covered, starting with welding and welding equipment through jigs and fixtures, government specifications, inspection and repair welding. Following each chapter is a series of questions intended to test the reader's knowledge of the foregoing text, with answers provided at the back of the book. Well illustrated with sketches, photographs and charts.

Aircraft Spot and Seam Welding, by G. Kuntz, 1942, Pitman Publishing Co., 108 pages. Price $1.50.

The author states that this book has been written to aid those engaged in spot and seam welding to better understand the mechanism of the equipment and its operation. Beginning with a history of aircraft spot welding, succeeding chapters discuss the theory of the spot weld, the spot-welding machine, materials, operating a spot welder, inspection and corrosion design for spot welding and finally practical suggestions for spot and seam welding. The text is liberally supplemented by photographs, sketches, charts and tables.

BASTIAN-BLESSING WINS SECOND ARMY-NAVY "E" AWARD

Employes of The Bastian-Blessing Co., Chicago, have won for the second time the Army-Navy Production Award for meritorious services on the production front. In conferring the award Under-Secretary of War, Robert P. Patterson said: "You have continued to maintain the high standard you set for yourselves and which won you distinction . . . you may well be proud of your achievement."

The Company feels that it has been fortunate in receiving a number of war contracts for equipment and parts requiring the same machines as those used in making its peacetime lines of Rego welding and cutting equipment. This will make it possible to reconvert quickly to its peacetime lines when the time comes, and to utilize the new skills developed by employes under the unusual demands for speed and precision work on war products.

ARMY-NAVY "E"

Army-Navy "E" Awards were formally presented to the Birmingham plant of the Chicago Bridge & Iron Co. at Birmingham, Ala., on May 2nd, and the Dry Dock yard operated by the company at Morgan City, La., on May 4th. Admiral James P. Mathews, U. S. Navy, Superintending Civil Engineer, Area 4, New Orleans, La., made the formal presentations of the "E" flags at both locations.

Approximately 65% of the tonnage fabricated at the Birmingham plant of the Chicago Bridge & Iron Co. is for LST ships or dry dock construction. The plant prefabricates sections for the bow end of LST's assembled at the company's yard at Seneca, Ill.

Most of the steel fabricated for dry docks is supplied to the Morgan City yard; although, some tonnage is shipped to the company's yard at Eureka, Calif.

The company's plants at Chicago, Ill., and Greenville, Pa., also supply prefabricated material for the construction of LST's at Seneca and for the building of dry docks at Eureka, Calif., and Newburgh, N. Y.

SYMPOSIUM ON THE SIGNIFICANCE OF THE HARDNESS TEST OF METALS IN RELATION TO DESIGN

This symposium, recently issued by the American Society for Testing Materials, includes notes on the indentation hardness test by Prof. J. M. Lessells, with conversion tables and a short selected bibliography. There are technical papers on present types of hardness tests by Prof. S. R. Williams, and on fundamentals of hardness testing by S. L. Hoyt, followed by interesting discussion contributed by other authorities, and finally, the tentative hardness conversion tables for steel showing the relationship between diamond pyramid hardness, Rockwell and Brinell values, A.S.T.M. designation E 48. This is the second of a series of symposiums being sponsored at periodic intervals involving critical discussion of the significance of various tests of metals. Copies of this 60-page booklet in heavy paper cover can be obtained from A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia 2, Pa., at 75 cents each.

DODS PROMOTED

John P. Dods, Director of Research and Advertising Manager for the Summerill Tubing Co., Bridgeport, Pa., has been appointed Director of Advertising and Sales Promotion for the closely affiliated interests of The Columbia Steel and Shafting Co., The Edgar T. Ward's Sons Co. and the Summerill Tubing Co.

Through this change the advertising of these affiliated interests will be better coordinated. The Edgar T. Ward's Sons Co. is one of the oldest and better known distributors of cold finished steel, with offices and warehouses in ten principal cities from Boston to Milwaukee. It will continue to function, with added facilities, as the Sales Representative and Distributor for the cold drawn bar products of the Columbia mill, and the many types of tubular products produced by Summerill.

Mr. Dods, Cornell, '08, has been connected in various capacities with these organizations for many years. He has already assumed his new responsibility in handling advertising, technical literature

PAGE *Welding* ELECTRODES

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and other promotive activities, with offices in the Norristown, Penn Trust Building, Norristown, Pa.

WINTER MADE VICE-PRESIDENT

Otto W. Winter has been appointed vice-president of the Acme Pattern and Machine Co. of Buffalo, N. Y. To Acme's 40 years of experience is added Mr. Winter's extensive background in tool engineering fields. A former national president of the American Society of Tool Engineers his experience after several years as an itinerant toolmaker includes the following: President and Works Manager, Sav-Way Industries, Detroit; Vice-President in charge of manufacturing, Republic Drill and Tool Co., Chicago; Factory Manager, Columbus McKinnon Chain-Chisholm Moore Hoist Corp., Tonawanda, N. Y.; Industrial Engineer, Kent-Owens Machine Co., Toledo, Ohio; General Manager, Cutter and Special Tool Division, Whitman and Barnes, Inc., Detroit; Tool Engineer and Sales Engineer, Cincinnati Milling and Grinding Machines, Inc., Cincinnati, Ohio, and a period in Russia as a consultant on machine tool and cutting tool manufacture to the Soviet Gove nment Mr. Winter personally engineered the Russian milling cutter design standards. Currently he is national chairman of the Education and Training committee of the American Society of Tool Engineers. He is also a member of The American Society of Mechanical Engineers, the American Society for Metals, the AMERICAN WELDING SOCIETY and the Society of American Military Engineers.

AIKENS JOINS DOCKSON CORP.

C. J. Koller, president, announces the appointment of Allen Aikens as General Sales Manager of the Dockson Corp.

Mr. Aikens has been with the company since 1932. In recent years he acted in the capacity of Sales Manager of the Western Division. Prior to joining the Dockson Corp. he was connected with The Linde Air Products Co. for seven years. His long experience in the industrial welding field and his familiarity with markets throughout the country give him an excellent background for his new post in which he assumes full responsibility for all the sales and promotional activities of the company.

CLEANING CONFERENCES

Concurrently held in New York, Chicago and Los Angeles were the Oakite Third War Production Conferences on cleaning, descaling, derusting, degreasing and related production and maintenance operations. Participating with the entire Field Technical Service Representatives were the staffs of the Mechanical Engineering, Chemical and Research Laboratories and General Headquarters of Oakite Products, Inc.

These 2-day sessions were devoted to the collating of field experience in order to determine the most practical methods for stepping up wartime production through speedier cleaning, due consideration being given to the emergencies of manpower and the shortage of time.

Preparation of aluminum for spot welding, anodizing. Alroking, and painting other surface finishing operations; stripping identification paint from aluminum and aluminum alloys was discussed.

Data and information resulting from the discussions held at the various meetings are freely available to all through the medium of the Oakite Technical Field Service.

WELDING DISTRIBUTORS ASSOCIATION

Mr. Allan W. Gordon, Welding Distributors Assn., 494 Arcade Bldg., St. Louis 1, Mo., Telephone Central 4426, has been appointed executive secretary of this association. He brings to the association considerable experience in this type of work.

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If, in your manufacturing processes, your product must be turned or tilted for accessibility, consider the use of Ransome Welding Positioners . . . for easier handling, faster production, better quality work, and reduced worker fatigue.

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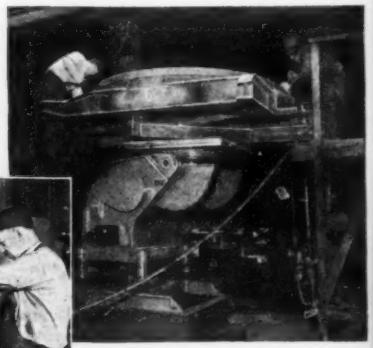
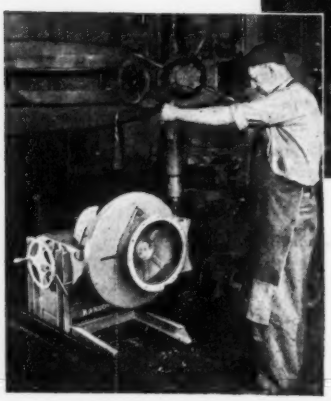
By quickly positioning work, a better and faster grinding or chipping job can be accomplished.





DRILLING

Work can be positioned for drilling at different angles by simply tilting or turning the positioner table top.

Hard surfacing, assembly, repair or overhauling of intricate units, flame hardening and flame cutting, spot welding castings, are other Ransome applications.

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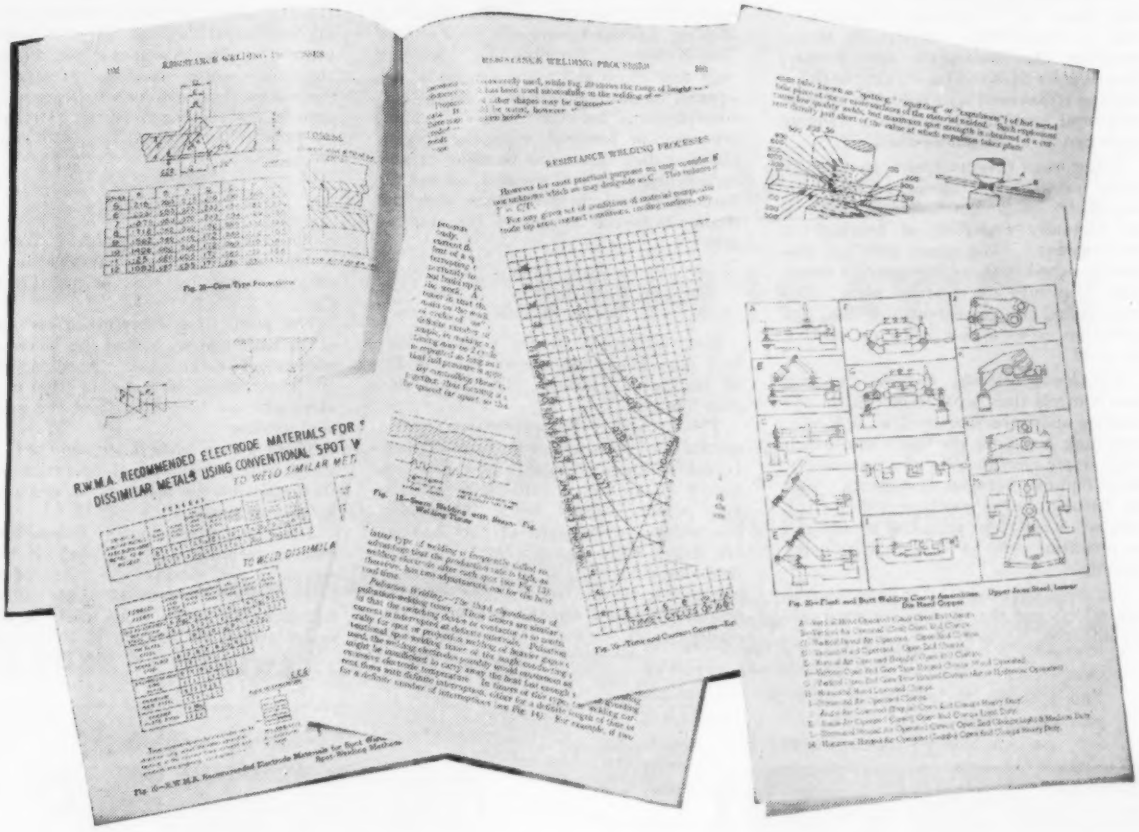
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BULLETIN ON STRUCTURAL ALUMINUM WELDER

A technical bulletin (No. 103), available from the Progressive Welder Co., 3050 E. Outer Drive, Detroit 12, Mich., describes the company's new Rocker-Arm Welder designed for making between 500 and 1000 sound spot welds per hour on structural sections of aluminum ranging up to two $^1/_8$-in. thicknesses of 24ST.

A feature of this machine is the rigidity of the frame which insures that deflections caused by maximum welding pressures are virtually negligible at bearings or transformers. The upper arm has also been designed to throw any possible minor deflections into the vertical plane, thus maintaining tip alignement and using the deflection as a "spring follow-up" during the weld.

Additional features include the two foot controls that separately control the working and retracting strokes; a $4^1/_2$-in. retracting stroke for the upper arm which gives ample clearance for the insertion of flanged pieces between the points; and the solenoid valves which provide for the application of a light preset air pressure to the operating cylinder for facilitating point dressing.

The over-all height of the machine is only 60 in., and the throat opening is adjustable from $7^1/_2$ to $17^1/_2$ in.

MAINTENANCE OF TOOLS AND DIES

The C. E. Phillips & Co., 2750 Poplar St., Detroit 8, Mich., has issued a 16-page engineering pamphlet on *"Crucible Arc" Welding Rods and Electrodes for Tool and Die Welding*. "Crucible Arc" welding rods and electrodes were especially developed for the maintenance, salvage and construction, by the fusion welding processes, of forming, stamping, forging blanking dies. They can be used on and carbon and alloy steels, water, oil and air hardening steels in accordance with the recommendations suggested for application.

TOOL REPAIR

How to Repair Broken Cutting Tools with Easy-Flo is the title of Bulletin 13, of Handy & Harman, 82 Fulton St., New York, N. Y.

This booklet is a comprehensive treatise on the subject of repairing broken tools. It fills a long-felt need throughout industry for an instruction booklet on the most popular method of repairing tools in use today. The pages of this booklet are filled with down-to-earth, instructional copy covering a subject of vital importance to the war effort. And it is profusely illustrated for the benefit of the reader.

CONTROL OF ELECTRIC MOTORS

Control of Electric Motors, by P. B. Harwood. Second edition. The characteristics and control of electric motors, including additional data on variable voltage control, single-phase motor control, synchronous motor control, present-day methods and devices for acceleration, systems for main rolling mill drive. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Price, $5.00.

A.-C. WELDERS

The growing popularity of A.-C. Welders is depicted in a 32-page pamphlet on the subject issued by the General Electric Co.

The publication explains clearly some of the basic reasons behind this increasing widespread acceptance. Also included are experiences of some of the many users who are benefiting from the use of a.-c. welding.

There is a complete description of G. E. a.-c. welders for manual operation and the details on the many G. E. electrodes for a.-c. welding.

There is a discussion of "Deep-Fillet" welding technique; of a.-c. welders built especially for outdoor use; and of the first all-position a.-c. electrode offered especially for work that meets E-6011 specifications, G. E. type W-26.

Ship'g weight, 20650 pounds. Length, 23' 0" Width . . 4' 6" Height . . 3' 0" Thickness of plate, ½", ¾" and 1¼".

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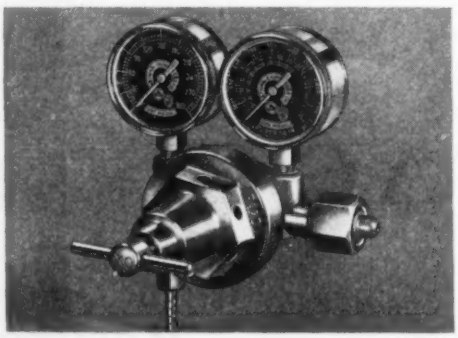

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AIRCO GAS PRICE LIST

The Air Reduction Sales Co. announces the publication of a 20-page, Revised Price List, "Gas and Electric Welding Supplies and Accessories." This list supersedes similar previous lists.

The Products in the revised list include Gas Welding Rods made in a wide range of metals, types and sizes for all welding requirements. Other products listed and described are Hard-Facing Alloys, Brazing Alloys, Fluxes, Helmets, Goggles, Gloves, Aprons, Welding Cable, Cable Lugs and Ground Clamps.

In addition to prices, the contents include detailed information of assistance to buyers, such as: sizes, dimensions, weights, stock numbers, forwarding data and recommended uses for products.

Among the new items described are the Airco No. 66 Welding Helmet which is leakproof. The headgear is adjustable to headsize and is of the sliding type, with two positive stop joints that always keep it centrally located. There are no outside projections to interfere with the welding operator when working in close quarters.

Another new item is the Suregrip Rod Saver that effects savings in electrode cost of from 7 to 14% because only $^5/_8$ in. of the bare electrode can be inserted in the socket, thus eliminating wasteful overhang. The design of the handle with 28 large openings materially reduces contact with the welders' gloves and minimizes overheating, even when electrodes are burned to a 1-in. stub. Electrodes are firmly gripped by a quarter turn of the handle. The handle is made of insulating material not affected by moisture or heat.

Also described is the Atlas Model A Dual-Tool for cleaning welds. This is a dual purpose tool that cuts down tool handling time. It consists of a chisel-headed Chipping Hammer combined with a Wire Bristle Brush. The brush-reversing feature doubles its life. All parts are readily replaceable.

Copies of this revised price list can be obtained by writing to the main office of Air Reduction Sales Co., 60 E. 42nd St., New York 17, N. Y., or to any of their many branch offices and authorized distributors.

NEW CARGO PLANE OF STAINLESS STEEL

A new air cargo plane, known officially as the "Conestoga" in tribute to the amazing vehicle which helped pioneer the settlement of colonial territories west of the Alleghenies, has been put into full-scale production by the Edward G. Budd Manufacturing Co. in its new airplane plant near Bustleton on the outskirts of Philadelphia. (See cover picture.)

Rated as one of the best kept secrets of the war in this area, the cargo carrier is of a brand new type which utilizes welded stainless steel instead of riveted aluminum alloy sheets for the first time on any considerable scale, in the history of the design of military and commercial aircraft. As such there is a strong possibility, in the view of aeronautical engineers, that the new plane will exercise a strong influence on the character of air transports in the future.

The Budd cargo plane was designed by a staff of Budd engineers directed by Dr. Michael Watter, a veteran airplane designer with a number of famous craft to his credit. It was developed under sponsorship of the Navy Department, Bureau of Aeronautics, and is being built under a Navy Department contract

Huge New Plant Built

The new airplane plant and flying field near Bustleton where the planes are being assembled was built for Budd by the Defense Plant Corp. and is known as Budd Field. The property covers 557 acres. The assembly building itself is a huge structure 1800 ft. long and 550 ft. wide covering $24^1/_2$ acres. The building was constructed largely of concrete to save critical steel, and has great concrete archs of revolutionary design supporting the roofs. There are two assembly bays 122 ft. wide and 64 ft. high, and six manufacturing bays each 50 ft. wide, all running the length of the building. Each of the assembly bays is designed to house a line of 26 planes in process of assembly.

The airfield adjoining the plant has two runways each 4400 ft. long. Operations are directed from a control tower, equipped with the latest facilities and operated under the supervision of Civil Aeronautics Administration.

INTRODUCTORY $10.00 PACKAGE

Contents—Manganal Special Tite-Kote Welding Electrodes—5 lbs. 1/4" x 18"—10 lbs. 3/16" x 18"—5 lbs. 5/32" x 18" for A.C. & D.C.

Seaco—Hard Facing Electrodes—5 lbs., 3/16" x 12" for A.C. & D.C.

For welding of 11 to 14% Manganese Steel

Gyratory, Roll, Jaw Crushers, Dipper Teeth, Pump Shells, Impellers and all Equipment that wears due to impact and abrasion.

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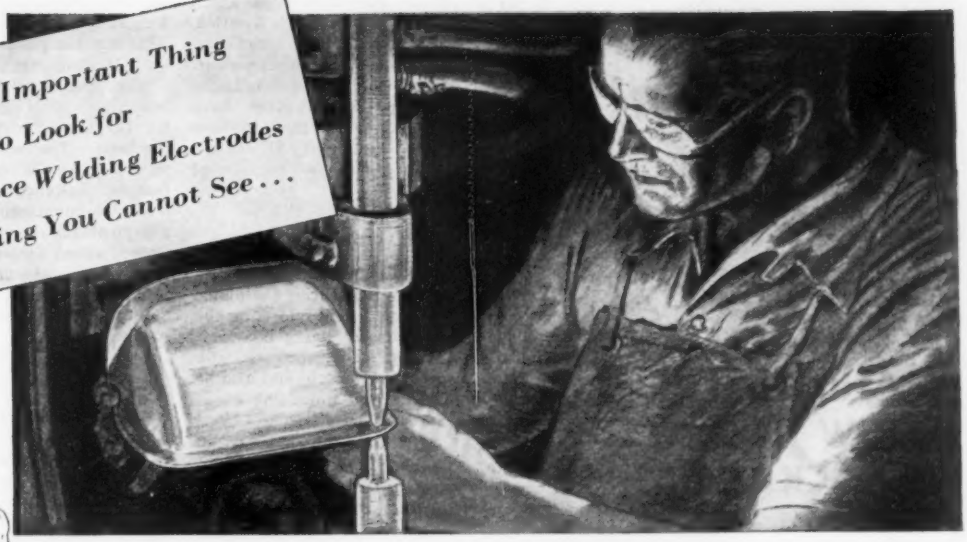
The Most Important Thing To Look for in Resistance Welding Electrodes is Something You Cannot See . . .



Mallory Experience . . .

Unseen Element Behind the Latest Advancements

Every resistance welding electrode, holder, casting or forging of a Mallory alloy incorporates definite, carefully controlled physical and electrical advantages. Behind these advancements is an invisible element —the plus factor of Mallory experience.

Mallory experience, for instance, formulated Mallory 3 Metal for welding cold-rolled steel faster, more soundly and at lower cost . . . tough Elkonite*, with its extreme hardness for electrical upsetting. Mallory's recommendations on size, construction and contour of electrodes represent accumulated studies dating back to the early days of resistance welding.

Not only does Mallory have electrodes of correct properties for wide and varied industrial requirements, but it places at your service engineering skill to solve unusual and baffling problems. Write Mallory for specific recommendations on how to speed production, cut down welding costs, with better electrodes for spot, seam, flash or projection welding.

*Elkonite is the registered trademark of P. R. Mallory & Co., Inc., for refractory metal compositions

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New Mallory Heavy-Duty Holder: Streamlined, tough, with single piece housing to protect vital inner parts and eliminate leakage troubles. Tip is quickly ejected by hammer blow at opposite end.

Freedom Is Worth the Price — Buy More War Bonds

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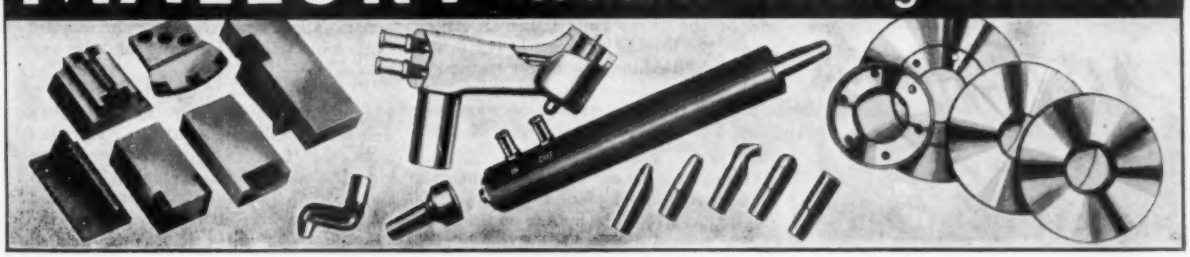
MALLORY *Standardized Resistance Welding Electrodes*



electronic Weltronic bulletins

ELECTRONIC CONTACTOR AND TIMER NOW IN ONE "PACKAGE"

New Weltronic "package" units eliminate inter-unit wiring, simplify installation, permit mounting on machine, if desired, speed delivery of equipment. Available with any A, B, or C ignitrons and timers of any NEMA type (interchangeable in cabinet through EXCLUSIVE PLUG-IN feature). Universal power unit works on 115, 230 or 460 volts. EXCLUSIVE simplified circuits with fewer tubes for lower maintenance. No re-wiring needed to add synchronous timing or heat control later for welder conversion.

Converts mechanical into electronic welders

Ask for Bulletin #120-75

Weltronic COMPANY

DETROIT 19, MICH.

The cargo plane was brought into being at the outset to provide a type which could be used on routes in South America, where unimproved fields and short runways are common. Since its development, however, the uses to which the military services plan to put the airplane have broadened to such a degree that it is now expected it will be used on military air cargo routes in practically all theaters of the war.

Designed as Cargo Carrier

The plane was designed specifically to be a cargo carrier. In creating the plane, the engineers centered their efforts on the problem of designing a "flying box-car," which could carry freight economically on flights of moderate length, and also be capable of loading and unloading cargo with utmost ease and speed.

The plane is a two-engine transport 68 ft. long, with a wing spread of 100 ft., and is capable of transporting 10,400 lb. of cargo over a range of 650 miles under A.C.A.A. license. Its 14-cylinder radial air-cooled engines deliver 1200 hp. each for take off and have a normal rating of 1050 hp. Having in mind the types of airports from which it might be forced to operate, the designers provided that the plane should be able to get into and take off from short landing strips, even with heavy loads. In tests the plane demonstrated that in normal operation it could lift 10,400 lb. of payload off the landing strip in a run of only 920 ft.

Provide Ramp for Loading

Aside from its type of construction and unique appearance the plane's most distinguishing characteristic is its provision for carrying cargo, and a ramp to facilitate its loading and discharge. The cargo compartment is a space 25 ft. long, 8 ft. wide and 8 ft. high, wholly unobstructed by structural members. The plane is equipped with a large cargo hatch in the underbody. This hatch may be lowered to form a ramp to the surface of the landing field, or a loading platform level with the platform of a truck. Back of it are two large clearance doors which may be lifted out of the way to provide the necessary headroom to utilize the 8-ft. square cross section of the cargo compartment.

The upward sweep of the afterbody of the plane provides a large clearance below the fuselage and back of the ramp to allow trucks to be moved close to the fuselage so as to pick up or discharge shipments. Provision is made for handling cargo with the aid of a specially designed hoist fitted above the loading ramp, and a manually operated winch mounted on the forward end of the cargo compartment. These permit the loading of large, heavy pieces of freight, machinery or motor transport. Both an ambulance and a jeep can be rolled into the cargo space at once and still leave a large space for stowage of other cargo.

One of the most advanced developments in the design of the plane for cargo handling is that all loading is done on the level. On the ground and in the air the floor of the cargo compartment remains horizontal which obviates the necessity of hauling freight up an inclined floor before stowage. This is made possible by the use of a tricycle landing gear.

The unusually large cargo space is made possible through a unique design for the attachment of the wing to the fuselage. The wing structure does not pass through the fuselage in conventional fashion. Instead, Budd designers, through a novel arrangement of the fuselage, were able to attach the wings to five special side frames joined across the body by shallow, but rigid transverse members, thus providing headroom of 8 ft. or 2½ ft. more than that possible with conventional structure.

Can Be Used as Troop Transport

Although primarily a cargo carrier, the plane can be coverted to troop transport or to aerial ambulance use. Provision is made for installation of 24 seats and 24 stretchers. There is a possibility that the plane may find an important use in the evacuation of wounded from battle areas to base hospitals behind the lines. That explains the provision for the loading of stretchers. In such use the level loading feature will prove most advantageous as stretcher cases must be handled in horizontal position to insure their comfort.

Doors in opposite sides of the fuselage permit launching of paratroops from both sides simultaneously, and provision also is made for the discharge of cargo, or paratroop supplies and equipment, by parachute through the opened clearance doors in the aft portion of the body.

The tactics in connection with the landing of paratroops require that as large a force as possible be concentrated in a small area. The usual transports used for hauling paratroops are equipped only with one launching door. The Budd plane, with two, allows these troops to be landed twice as quickly. Furthermore, some of the services provide for the landing of supplies and equipment, in separate launchings. The Budd plane permits this to be done through the opened clearance doors at the same time the paratroops are put overside and assures that the material lands with the troops.

Crew of Two Required

The plane requires a crew of two, a pilot and a co-pilot, whose quarters are in a roomy, comfortable, full-height operating compartment in the nose of the plane. As much engineering attention was given to the design of this compartment as to the facilities for handling cargo. Pilots who have flown the plane complimented the designers on this feature. Dual controls are installed, as well as remote-control radio and facilities for blind landings and take offs.

According to the test pilots the plane is easy to fly, having exceptional stability and well-coordinated controls. The pilot who took the first plane off the ground reported after the first flight, "A little boy could fly it." The demonstrated excellent flying characteristics of the "Conestoga" fulfill one of the principal

648 HARD-WORKING POUNDS of Welding Ability

There is no substitute for active metal in producing welding current. That is why this P&H welder out-performs other welding machines. Compare its weight, its range, its operating advantages — on a dollar and cents basis.

"VISI-MATIC" CALIBRATION

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WSR
(Welding Service Range)
RATINGS
BASED ON ACTUAL DELIVERED OUTPUT OF USABLE WELDING CURRENT

30-285 AMPERES CAPACITY

Here is a machine in a class by itself, designed to serve the widest possible range of applications in general welding practice. It's an "in-between" capacity that overlaps the ability of smaller and larger machines. It's a standout in performance — and value!

WRITE FOR FULL DETAILS

Why postpone the advantages and the economies this better welding service can bring you? Write for all the facts about this 30 to 285 ampere capacity welder.

A COMPLETE ARC WELDING SERVICE

DC WELDERS | AC WELDERS | WELDING ELECTRODES | WELDING POSITIONERS | PRODUCTION CONTROL SYSTEMS

P&H ARC WELDERS

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Two electrodes which operate on both AC and DC welders! Conform to AWS and ASME class E-6010 and 6011 and E-6012 and 6013. Write for information about AC-1 and AC-3 electrodes.

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Sixty Years of Service

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objectives of its designers, namely, to provide an airplane of its weight and power which could be flown by pilots of limited experience.

High Payload Ratio Noted

The effective way in which stainless steel has been used in aircraft design in the Budd plane is disclosed by the fact that although the total weight of plane and full load is 33,800 lb., 10,400 lb. represents the weight of cargo. This is an unusually high ratio of total payload to total weight.

With a full load, including equipment, fuel and the crew, the plane at a cruising speed of 165 mph. will have a range of better than 600 miles. The maximum range with available fuel tankage will be about 1700 miles. This can be increased up to 3500 miles with auxiliary fuel tanks.

The cruising speed is around 165 mph. At this speed the two engines each will deliver only 710 hp., thus providing an exceptionally economical consumption of fuel.

The Navy accepted the Budd design early in 1942 and in May of that year construction of the Budd Field Plant and airfield began. The formal contract was granted in August 1942. The static test plane was finished August 12, 1943, and the static tests completed Oct. 27, 1943. The initial test flight was made Oct. 31, 1943.

A photograph of this cargo plane is shown on the front cover of this issue.

OBITUARY

Franz Eder—Consulting Engineer—1879–1944

Mr. Eder was a native of Austria and after completing his technical education joined the staff of a car builder in Rabb, Hungary, and later became Assistant Superintendent. While there he became acquainted with the European organization of Robert W. Hunt Co., Engineers, and shortly after his arrival in the United States in 1907 joined the Hunt organization, remaining with them until his death on April 28, 1944.

Early in his career Mr. Eder became interested in the development, design, methods of manufacture and testing of compressed gas cylinders and various types of pressure vessels.

He devoted many years of study to the development and control of fusion and gas welding and was the author of several papers on these subjects, and served actively on committees appointed by technical societies interested in the advancement of the art.

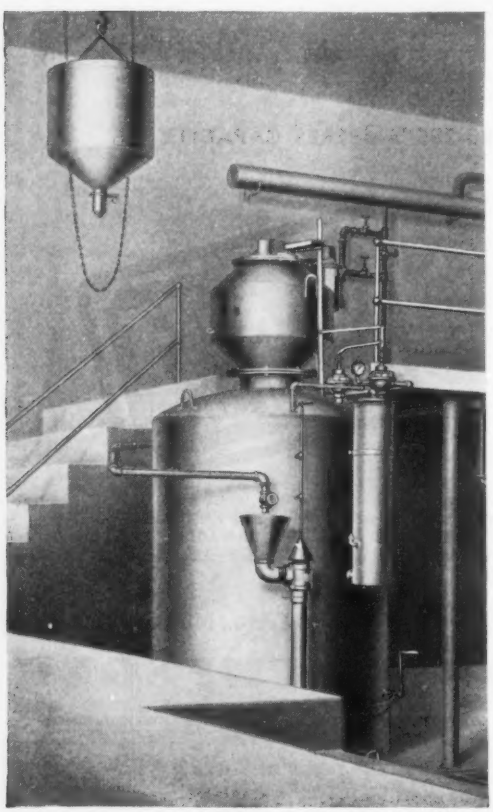
Mr. Eder was a member of the AMERICAN WELDING SOCIETY for many years, having joined the SOCIETY in 1930. During that time he served on various A.W.S. technical committees, including Committee on Building Codes, Committee on Standard Tests for Welds, Committee on Standard Qualification Procedure, Committee on Recommended Practices for Inspection of Welding and various subcommittees of these committees.

SAFETY IN ELECTRIC AND GAS WELDING AND CUTTING

Safety for the protection of workers from injury and illness and for the protection of property from fire or other damage arising out of the installation, operation and maintenance of electric and gas welding and cutting equipment is the purpose of the new American War Standard "Safety in Electric and Gas Welding and Cutting Operations, Z49.1."

Intended as a guide for the establishment of safety rules to meet the particular problems of different installations, recommendations are provided for the installation and operation of Gas Welding and Cutting Equipment, Arc Welding and Cutting Equipment, and Resistance Welding Equipment. Recommended rules for Fire Prevention, Protection of Personnel and Ventilation and Health Protection cover the use of goggles and shields, protective clothing, as well as first aid and ventilation requirements for the welding of steels and non-ferrous metals in the protection of welding operators and other workers.

Copies may be purchased at 40¢ each from the AMERICAN WELDING SOCIETY, 33 West 39th Street, New York, 18, N. Y., or from the American Standards Association, 29 West 39th Street, New York 18.



What Size, Please?

● Little or big, portable or stationary, Sight Feed has just the Acetylene Generator to fit *your* welding needs. Five portable models range in capacity from 6 to 100 pounds of carbide per charge—generating 30 to 500 cubic feet of purer, hotter acetylene gas. Five stationary models hold from 125 to 600 pounds of carbide, and will give you 595 to 2840 feet of acetylene without refill. So, just let us know *which size* Sight Feed will best serve your particular requirements, and we'll make delivery promptly. Or if you wish more detailed specifications, just say the word and we'll send 'em by return mail.

THE Sight Feed GENERATOR COMPANY

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TIME AND MONEY SAVING PRODUCTS FOR PREPARING ALUMINUM FOR PAINTING AND ANODIZING

DEVELOPED BY DIVERSEY

HELP WANTED!

Here's one "help wanted" problem that's easily solved . . . even in these days of man-power shortages. If it's a problem in metal cleaning and working . . . the Diversey D-Man is always on deck to lend a helping hand. Backed by a Research Laboratory that has spent 18 years developing special purpose products, the Diversey D-Man can often show you ways to step-up production that require less man-power.

DIVERSEY D-MAN

Simple Cleaning—For cleaning aluminum prior to painting or anodizing, the Diversey Research Laboratories have made available four different products, each with specific properties to meet varying requirements and conditions. They include Diversey Aluminum Cleaner, S S Aluminum Cleaner, Diversey D-C No. 36 and D-C No. 38.

At the moment Diversey D-C No. 36 is perhaps the most popular. Recently, markings on aluminum sheets have been changed and these new markings have been quite a problem with ordinary cleaners. D-C No. 36 not only removes such markings completely but does the job in about one-fifth the time ordinarily required.

Anodizing—Electrolytic Process—Prior to anodizing by the electrolytic process, aluminum must be thoroughly cleaned. For this purpose, the four products mentioned above are recommended. In each, powerful cleaning action is supported by unusual wetting and emulsifying properties which quickly and completely removes oil and grease. At the same time, special inhibitors prevent pitting, staining or discoloring of the aluminum surface.

Anodizing—Non-Electrolytic Process—In this process, pre-cleaning is also essential. For this purpose, D-C No. 36 is particularly recommended because of its unusually effective free-rinsing action. It leaves no film on the surface to interfere with the subsequent successful completion of the operation. For further details write Metal Industries Department.

THE DIVERSEY CORPORATION
53 W. Jackson Blvd., Chicago 4, Ill.

BROKEN BLANKING DIE RECLAIMED BY WELDING

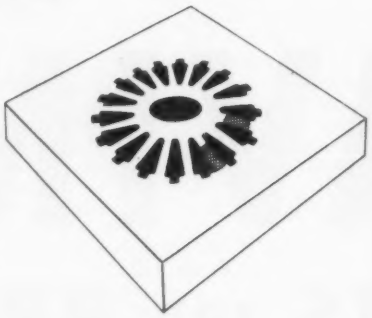
By Pete Marose*

A BLANKING die in the plant of the New Monarch Machine and Stamping Co. broke in the press during a punching operation and a new die would have taken 3 wk. to make at a cost of approximately $200. The foreman of the plant asked about the possibility of repairing the break by arc welding and it was decided to try it out on this tool steel die.

Taking the die apart, we veed out the breaks and placed the die in the oven at 300° F., at the same time placing in the oven a piece of cast-iron block. After both were thoroughly heated we took them out and, placing the die on the block so that it would not cool too rapidly, we proceeded to weld the breaks with a 1/8-in. tool steel electrode with the welder set at 100 amp. We would weld a small bead at a time, peening each weld thoroughly as we went along until the break had been filled. We then placed the die back in the oven and draw dipped in oil to harden. After grinding and placing back in the press, the entire repair bill had cost $10.

A new die would have cost around $200 and would have caused considerable delay in our production. Our repaired die is still in operation and has since turned out over 500,000 steel and 300,000 fiber stampings.

*Des Moines, Iowa.



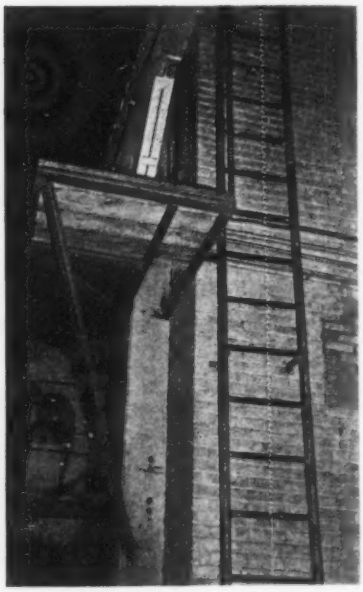
Drawing and data, courtesy The Hobart Bros. Co

WELDED LADDER AND PLATFORM FACILITATES SERVICING OF POWER CRANE

A ladder and platform that requires a minimum of space and materials, yet costs only a few dollars and permits faster and safer servicing of a plant power crane is one of the many kinds of structures fabricated by arc welding in the modern factory.

The example shown in the accompanying photo is typical of the simple yet strong designs that can be constructed with the electric arc.

In this case, it was desirable to locate the platform at one end of the crane tracks, away from the area in which shop



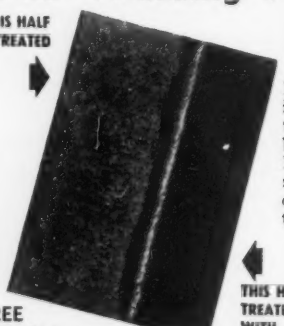
Data and photo, courtesy The Lincoln Electric Co.

Welded Ladder and Platform for Servicing Overhead Crane Shows Simplicity of Welded Design

Save Time and Labor Costs:
Cut Down Fumes 30%:
Protect Metal Against Rust:
Get Unimpaired Welding Strength:
Do Cleaner Better Work—with

NO-SPAT

The Welding Fluid that Is Non-Toxic



NO-SPAT prevents welding spatter from adhering to metal surfaces—Unbiased scientific tests show NO-SPAT maintains maximum weld strength—reduces fumes 30%, is non-toxic—does not produce carbon monoxide.

NO-SPAT requires no mixing — apply and start welding at once. No time wasted.

THE MIDLAND PAINT & VARNISH CO.
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the parts you can't replace...
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YORK'S 77
CAST IRON BRAZING
FLUX

1. Fear of overheating cast iron can be forgotten with "York's 77". Bronze can be applied from a dull red heat up to the molten point of the cast iron.
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Power Company Pays for Shipyard Welding Machines

The hp model 1010 Automatic Welding Machine Starter with Arc-time Totalizer is designed to operate in conjunction with any standard welding motor-generator set. It starts the welding machine when the welder touches the rod to the work. After a short interval of no welding, the control automatically stops the machine. Whenever welding is in progress, arc-time is counted by a synchronous totalizer. The totalizer does not operate when the rod is shorted to the work, thus only actual arc-time is recorded.

Photographs Courtesy Lincoln Electric Co.

THIS IS WHAT is actually happening in one of America's leading shipyards! Welding engineers discovered that their arc-welding machines actually ran idle 75% of the time they were turned on, wasting a total of 31.7% of the electric power consumed. They also found, by careful records of actual operation, that automatic starters on their welding machines, saved this power waste. The saving paid for the starters in 6 to 7 months. After that, the money the power company *didn't get* began to pay for the welding machines.

The automatic starter that turned this waste into profit, was the -*hp*- Arc-O-Mat.

If *you* were to make stop-watch tests of just how much "idling time" your welding machines have . . . just how much power they waste . . . you too would probably be unpleasantly surprised. We have a reprint of the report made by these shipyard engineers; a copy of it is yours for the asking. It will start you on the road to ending your waste of welding power by idling machines. You incur no obligation. Just drop us a line asking for the "Shipyard Waste-Power Report" today . . . NOW!

hp ARC-O-MAT

HEWLETT-PACKARD COMPANY • PALO ALTO, CALIFORNIA

Box 809F, Station A

workers were operating, thus eliminating the danger of falling tools.

Using a factory upright for the main anchoring base, the platform was made by cutting several lengths of channel iron to form a square frame for a heavy plank flooring.

Two of the horizontal pieces were welded all around to the upright beam and adequate bracing was provided by means of two sections being welded to the underside of the frame, positioned at an angle and welded securely at points of contact with main upright. Ends of the braces were flame cut to effect a solid fit all around.

The ladder is of $1^1/_2$-in. piping with 1-in. angles as rungs welded to each vertical pipe section and securely bolted at intervals to the brick wall. Further rigidity was added to both structures by welding a short length of $1^1/_2$-in. channel between the platform and one side of the ladder.

MERRIHUE NAMED MANAGER G-E APPARATUS ADVERTISING AND SALES PROMOTION

Willard V. Merrihue has been named manager of the advertising and sales promotion divisions of the Apparatus Dept. of the General Electric Co., it was announced by the company May 3rd. Simultaneously he was named a member of the apparatus sales committee of the company. He was previously assistant to the manager of the apparatus publicity divisions, Robert S. Peare, whose election

Willard V. Merrihue

as vice-president in charge of the company's advertising, broadcasting and general publicity activities was announced a week earlier.

Mr. Merrihue started work in the editorial section of the company's publicity department in Schenectady in 1925, immediately after his graduation from the University of Pennsylvania with a degree of bachelor of science in chemical engineering. In 1930 he was named assistant manager of the industrial advertising section of the department, and in 1933 was appointed division manager of central station advertising. In 1939 he became assistant to the manager of the publicity department, in charge of the apparatus division, which position he held until his new appointment. In 1933 he received a Charles A. Coffin Foundation Award of the company for "initiative, ingenuity and perseverance in devising a new and unusual sales plan."

While in college Mr. Merrihue was editor of the *Pennsylvania Triangle* and eastern vice-president of Engineering College Magazines Associated, an organization of the outstanding college engineering publications in the country. For four years he was eastern vice-chairman and then for four years was national chairman, following which he was named honorary chairman. He has also served as national vice-president of Theta Chi fraternity.

Mr. Merrihue is a member of the Technical Publicity Association of New York, and has participated in numerous programs of the association, as a speaker or as a leader of seminar discussions.

Annual Meeting

Plan to attend

Oct. 16–19

HOTEL CLEVELAND

Cleveland, Ohio

WELDERS — SHIP FITTERS — PLATE FABRICATORS —

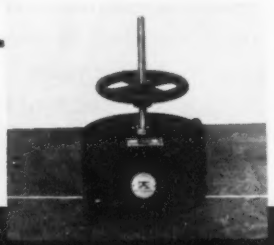
SPEED WELDING OPERATIONS

SAVE TIME, LABOR AND MATERIALS WITH

HERCO MAGNETIC ALIGNERS

Herco Aligners magnetically true-up and hold firmly in welding position, plates, beams, rods . . . eliminate time-consuming manual aligning, welding of temporary clamps, wedges or use of heavy weights to hold in position the parts to be welded. Hooked up to either AC or DC power, Herco Magnetic Aligners do the work normally required of a full man crew . . . in almost no time and with precise efficiency.

Herco Aligners are simple to operate, easy to handle and have a magnetic pull of 2,000 pounds per surface inch on one inch plate. Further details will gladly be sent on request.

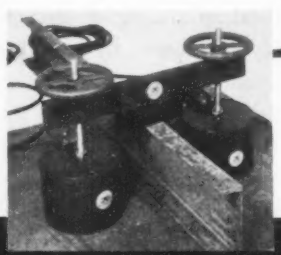


ALIGNING BUTT END PLATES FOR TACK WELDING

A Herco Aligner is placed squarely on the seam and when energized instantly draws both plates flush against the perfect surface of the magnet, thereby trueing up areas on both sides for tacking.

BUCKLING ELIMINATED BY PRESSURING STIFFENER BEAM

Shipbuilding requires reinforced stiffener beams across each plate at stated intervals. Warped plates are quickly positioned for welding to the stiffener beam by placing the aligner as illustrated.



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SPOT WELDERS • FLUORESCENT BALLASTS • SPECIAL CONTROLS

Magnaflux indications of subsurface slag inclusion in weld

Avoid Welding Failure In Service

BY REVEALING DEFECTS IN THE SHOP

INSPECTION...
DETECTION...
CORRECTION...

When the cause is interpreted the remedy is usually easy. Magnaflux is used to locate detrimental defects such as: (1) surface cracks in weld or parent metal. (2) lack of fusion—incomplete penetration. (3) large slag inclusions.

When a weld fails in service, it is too late to make it good. Losses of lives, time and dollars can never be replaced.

The Magnaflux* Corporation, pioneer in non-destructive inspection methods, has adopted a special approach to the difficult and highly specialized job of weld inspection—making it possible to locate detrimental defects *before* they have caused damage.

Recognizing the different requirements of aircraft welding, structural welding, and the welding of pressure piping and pressure vessels, the Magnaflux engineering and research staff has developed a special technique and equipment for each. *Now, by means of portable equipment EVERY WELD can be examined non-destructively, anywhere in the plant or yard!*

Your own men can be readily trained as Magnaflux Inspectors and with this new Magnaflux equipment, you can be free from the worry of passing defective welds. *Write today for a fully explanatory bulletin.*

**Magnaflux—the Trade Mark of the Magnaflux Corporation applied to its equipment, materials and inspection methods.*

MAGNAFLUX CORPORATION

5922 Northwest Highway, Chicago 31, Illinois

NEW YORK • DETROIT • DALLAS • LOS ANGELES • CLEVELAND • BIRMINGHAM

ARC-WELDED BOOM FEATURES RETRACTABLE SUPPORTING WHEELS

By Stephen E. Stawiarski*

Holyoke, Mass.

DURING the four years I served in the United States Army, one of the most important arc-welding jobs that was encountered was this boom that I designed and constructed for lifting engines, propeller assemblies, tail ends of planes, in fact, all general hoisting operations.

The boom was constructed of 1- and 2-in. aircraft tubing with a 1/4-in. wall thickness and was completely arc welded. The base is slotted and reinforced with 1-in. bolts holding it to two uprights made of armor plating set right in back of the bumper of the tractor. The boom was designed for lifting 10 tons but when attached to the 5-ton tractor for portability, it was necessary for us to design the wheel assembly which acts as a fulcrum and holds the tractor on an even keel when hauling excessive loads around the airfield.

The hook on the boom was made of six-sided bar stock and tempered just enough to bend at severe strain, and channel iron and sheet steel were used for the sheave, reinforced with bosses in each section to prevent buckling. The cable holding the boom is 3/4-in. flexible cable with a snapping point of 23.6 tons. It was spliced and placed right over the "ears" at the top of the boom, which are the reinforcements for the sheave.

Photos courtesy The Hobart Brothers Co.

Official U. S. Army Air Corps photos

The supporting wheel assembly was designed to be retractable so that the tractor could move the weight on the boom and deposit it with the least effort, saving time which is so valuable to Army Air Force Units. In the down position there is a clearance of only 3/4 in. above the ground, very little tilt being allowed. The wheel assembly is raised when the boom is idle and if the tractor is out servicing planes it is not in the way when tractor is traveling at a fast speed over rough ground.

*Former S/Sgt. U. S. Army Air Corps. Mr. Stawiarski has receatly received an Honorable Medical disability discharge and is now engaged in designing and fabricating materials by arc-welding for war industries.

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You're an American—*you* have a duty, too! Here's *your* chance to do *your* share—to fight by their side on every bitter beachhead in the world. The 5th War Loan is on—the biggest Drive for Dollars in all history. You *know* how you can help: BUY WAR BONDS WITH EVERY DOLLAR YOU HAVE! Now is the time to buy *extra* Bonds—as many as you can.

If you are already buying Bonds on a payroll savings plan, whoever you are, whatever you do, ask yourself this question: "What did I do today that some mother's son should die for me tonight?" Then *double* the Bonds you bought before—make them *know* you're with them! And not next week or next month, but NOW, when every bullet and every dollar counts MOST

And Here Are 5 MORE Reasons for Buying EXTRA Bonds in the 5th?

1. War Bonds are the best, the safest investment in the world!
2. War Bonds return you $4 for every $3 in 10 years.
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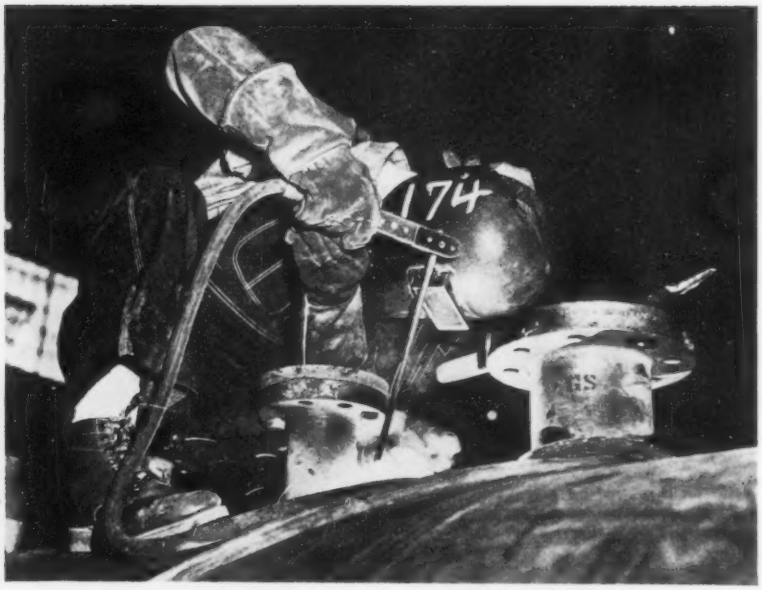
★ *This is an official U.S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council* ★



Official OWI photo, courtesy The Lincoln Electric Co.

Modern Boilermaker Puts Best Foot Forward

Welder number 174 illustrates up-to-date method of boilermaking by fusing a nozzle on a new high-pressure boiler for TVA hydroelectric system. This is one phase of arc-welded power plant construction as produced at Chattanooga shops of Combustion Engineering Co.

Electric Arc Gives New Life to Old Parts in Railroad Salvage Program*

PROBABLY no other industry has had a more critical problem than that faced by the nation's railroads in keeping their equipment in first class repair. Delivery of new parts, even when obtainable, usually means long delays that would tie up important rolling stock that is urgently needed in today's transportation crisis.

Most modern railroads have found the answer to this troublesome question through the skillful use of the electric arc process of welding. Now, many vital parts which were formerly discarded are repaired or rebuilt with a minimum of time and at a fraction of the cost of a new item.

The following are typical reclamation projects made possible by the advanced techniques now employed in the arc-welding process:

* Data and photos, courtesy the Lincoln Electric Railway Sales Co., Cleveland, Ohio.

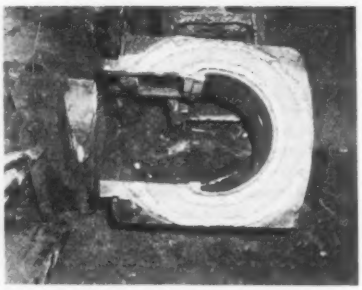


Fig. 1—Finish Welded Driving Box After New Steel Insert and Weld Metal Have Been Applied to Build Up Worn Hub Liner Surfaces

Restoration of Worn Locomotive Driving Boxes

Badly worn driving boxes are particularly important to any railroad maintenance program due to their relatively high cost and irreplaceability.

Worn portions of the hub liner are first built up by welding a steel insert over the worn area. The insert ring has an inside diameter of 13 in. and is $1^3/_4$ in. wide by $^1/_2$ in. thick.

Using the steel insert as a base, the liner is restored by building up the surface with stringer beads, using $^1/_8$-in. diameter electrode. Finish welds are made, using bronze electrode for high antifriction qualities.

Figure 1 shows a completely welded driving box ready for final grind finishing. Note the two broad, dense beads of weld deposit.

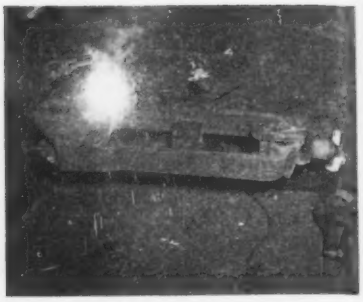


Fig. 2—Welding a Bad Fracture in a Coupler Yoke. Portion of Swiveled Positioning Fixture Is Shown Bolted to Wall at Rear

Repair of Yoke for Car Couplers

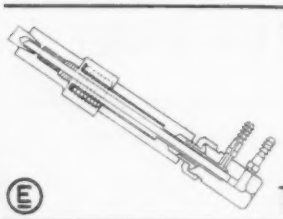
In this welding repair project, cracked and broken yokes are suspended in an ingenious holding fixture so that the part can be located in the best position for most efficient welding (see Fig. 2). Additional holding devices such as the one shown at the right in this view, can be easily attached to accommodate other parts.

In instances where the fracture is excessive, the crack is first vee'd out and a sufficient number of passes are used to build up the metal to its original thickness of $1^1/_2$ in.

As the average cost of this welded repair amounts to $3.17, and the cost of a new yoke is about $16, the road reporting this job estimates their savings last year on this part alone to be over $4000.

Rebuilding Worn Lock Block

This item, which is subject to extreme friction as a vital part of the coupler, was formerly thrown on the scrap pile when it became excessively worn. Areas measuring about 4 by 3 in. on the top and bottom faces of the block (see Fig. 3) became particularly worn beyond use after a certain period in service.



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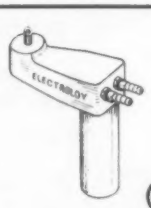

THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN.

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Fig. 3—Using Shop-Made Gage to Determine Proper Build-up of Weld Metal on Outer Surfaces of Worn Lock Block for Coupler

The method used for reclaiming this part by means of electric arc welding has been very effective. The maintenance department first cut a gage from thin sheet with inside opening to the exact outside dimensions of a new block. By using this gage as a guide (Fig. 3) the worn surfaces are built up to original specifications by weaving a bead of weld metal in two passes onto the worn areas. The new welded surface usually measures about $^1/_4$ in. in thickness. Any excess weld metal is ground off until the gage fits snugly over the block as shown in Fig. 3. A $^5/_{16}$-in. shielded arc electrode conforming to AMERICAN WELDING SOCIETY specifications, E-6012, is used throughout.

Savings on this part amount to approximately $1.42 per item, the repair cost averaging only 26 cents as against $1.68 for a new lock block.

STAND SAVES WELDING TIME ON WORN TRACTOR GROUSERS*

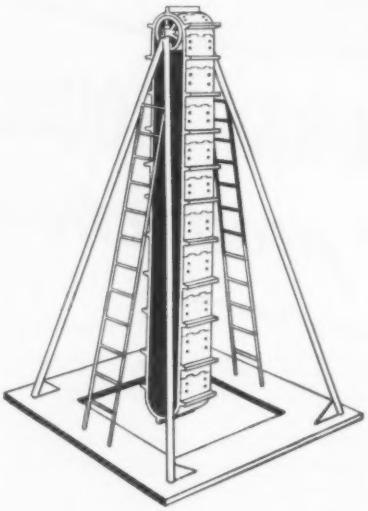
By Conrad D. Krantz†

THE Oliver Iron Mining Co. of Virginia, Minn., has 15 tractors to keep in operation and this stand for welding applicator bars on the worn grousers has paid for itself many times in the handling of the tracks during welding.

It only takes a few minutes to put up the track and take it down with the aid of a crane, there being only four bolts to take off. With this all-welded stand, it is very easy to turn the sprocket and get the grousers in the most convenient position to weld.

This stand was constructed from all scrap material picked up around the shop and its total cost including electrodes and power was only $22.25 and was completed in $2^1/_2$ days' time.

The applicator bars that the Oliver Co. use are manganese, averaging 12 ft. in length. It requires three bars to completely repair a worn track. First, cutting the bars to length, they are tack welded into position and then the first bead is



welded with $^5/_{32}$-in. stainless steel rod. On the second bead, $^3/_{16}$ or $^1/_4$-in. stainless is used.

*This article was one of the winners of an award in the Hobart Brothers Co. Arc Welding News Contest.

†Virginia, Minn.

OLD, BUT PRECISE HANDS AND EYES

The hand belongs to Warren Black, 79-year-old war worker who, unable to find employment 20 years ago, because "I was too old," can today distinguish the difference between 20,000th and 24,000ths of inch precision instrument wire. Here "Blackie" is "butt welding" the hot end of 24,000ths of an inch of thermocouple platinum and platinum rhodium wire.

"Blackie" is employed by the Brown Instrument Co., Philadelphia manufacturer of industrial measuring and control precision instruments. Inspectors have given "Blackie" a perfect record for 20 years.

SUSTAINING MEMBER

Thomson-Gibb Electric Welding Company, Lynn, Massachusetts. Elihu Thomson invented the resistance welding process in 1886.

Today, Thomson Production Welding Machines apply electrically generated heat in ingenious and precise combination with timing and pressure to perform a great range of metal joining and assembly operations with high efficiency and at low cost. The Thomson process includes spot, press and projection, seam, butt and flash welding, and the special production welding of wire fabric and of aluminum, stainless steel and other alloys.

Thomson-Gibb Electric Welding Company offices are maintained in thirty-seven industrial centers throughout the United States and Canada.

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A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; No. 16 Silver Solder Paste Flux.

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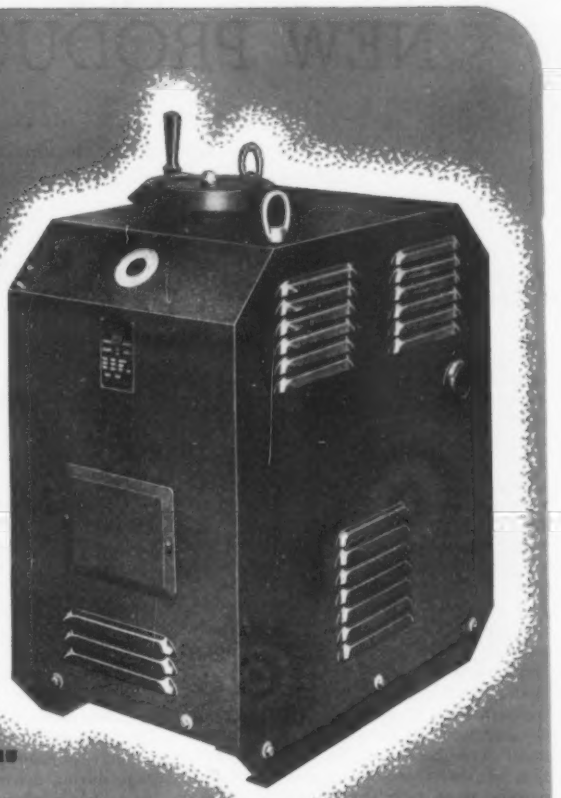

New G-R MODEL 38

With a welding range of 70 to 420 amperes, this modern G-R welder is an ideal unit for shop production work. Power factor correctors are standard equipment, built in. Class B insulation is used throughout. Output control is uniform and stepless, and welding characteristics are ideal at every point in the range. Handles overhead and vertical position welding with ease.

New G-R MODEL 49

Standard equipment includes Class B insulation, built-in power factor correction, and G-R VOLT-O-MATIC control (reduces open circuit voltage to less than 10 volts!). Welding range is exceptional... from 25 to 625 amperes! High efficiency, exceptionally fine welding characteristics at all heats, and smooth, accurate control make this versatile welder an all-around favorite for stepping up production and cutting costs to a minimum.

ABOVE MODELS FULLY PROTECTED FOR OUTDOOR OPERATION

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NEW PRODUCTS

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FROSTRODE STEPS UP CAPACITY OF INDUSTRIAL REFRIGERATION UNITS

Improvements in the complete line of "Frostrode" industrial refrigeration units, extensively used for "Zero-Welding" and other purposes, have resulted in a further increase in reserve capacity for these units, according to an announcement from Frostrode Products, 19003 John R, Detroit 3, Mich. Among contributing improvements is a new improved evaporator coil arrangement that eliminates all sharp bends, minimizes the back pressure of the refrigerant and permits unrestricted flow of the coolant. There are no low "pockets" to accumulate sediment and plug up. Improved refrigerant expansion valves have increased the sensitivity of this unit to temperature variations, insuring closer control of coolant temperature through faster response. Greater ease of inspection and maintenance have been provided through relocation of the thermometer bulb and expansion valve near the removable inspection panel.

The line now comprises four basic standard units, Models 751, 1501-E, 3002 and 5001, designed to maintain 0 to 10° F. coolant temperature during the continuous production runs of one, two, four and six light aluminum welders, respectively, or the equivalent load of steel welders or other machines. One or more coolant circulating pumps are built into the units as required for any specific operation. In addition, special units are available for use with low-temperature cabinets, test chambers, processing baths, etc. All units are now designed for the use of methyl chloride refrigerant in line with Governmental requests to conserve the supply of Freon for critical Service uses.

CONTROL ON A.-C. WELDERS

Now available for any a.-c. welder, the new G-R Volt-O-Matic control provides complete safety for the operator by reducing open-circuit voltage in the welding leads to less than 10 v. during nonwelding periods. An arc-time totalizer included in the unit, providing "production control" permitting more efficient use of welding equipment.

A low-voltage pilot circuit, closed when the operator strikes the arc, actuates a heavy-duty contactor which closes the power supply circuit, instantaneously providing full welding current and voltage to the welding leads. When the operator breaks the arc, the primary contactor disconnects after a brief delay, and voltage in the welding circuit drops to less than 10 v. An adjustable time-delay relay permits proper setting of the controls to suit the requirements of the welding operation. Because of the extremely low voltage during nonwelding periods, operators can change electrodes without a "sting," even when welding in the rain or on wet metal decks and structures.

The arc-time totalizer records actual welding time in hours and tenths of hours, providing a complete record of actual working time for each minute. Improper work distribution and other causes of idle welding machines and lost welding time can thus be spotted and corrected.

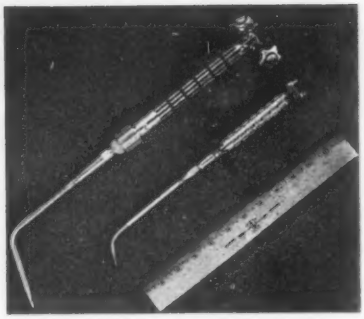
Full details may be obtained by writing to the manufacturers, Glenn-Roberts Co. 2107 Adams St. Indianapolis 1, Ind., or 1009 Fruitvale Ave., Oakland 1, Calif.

LIGHTWEIGHT WELDING TORCH

A compact lightweight welding torch, especially designed for use on aircraft tubing, aluminum, various alloys and all other sheet metal up to $\frac{1}{4}$ in. in thickness, is announced by the National Cylinder Gas Co. as a part of its new Torchweld line of welding and cutting equipment.

Weighing only $8\frac{4}{5}$ oz., complete with a commonly used size of tip, this torch, called the Aircrafter, has an over-all length of less than 12 in. The handle is $\frac{7}{8}$ in. in diameter and only $4\frac{1}{8}$ in. long.

Unusually easy to manipulate, the torch is designed for delicate, precision work in "hard-to-get-at" light metal work, and is expected to be exceptionally useful to women welders. Two styles of copper tips, both producing soft, medium-pointed flames that give deep penetration without blowing hot metal, are offered, and both can be swiveled to any position



Tip head for screw-in style tips is made of special heat-resistant cupro-nickel. Mixers incorporate the patented "nonflash" principle which has been a feature of Torchweld equipment for years.

The full new Torchweld line includes improved standard size welding and cutting torches, cutting attachments, machine cutting torches, single and dual stage regulators, a wide array of sizes and styles of welding and cutting tips and several complete welding and cutting outfits.

ARC WELDING OF ALUMINUM

The Research Department of the Eutectic Welding Alloys Co., New York, is pleased to announce a new electrode with a new coating which can now be used with great ease in the welding of aluminum sheet and castings. This new rod, known as EutecTrode 2100, opens a new field for arc welding—the salvage and reclamation of aluminum castings. It is possible, with this new electrode, to add metal without completely preheating the casting, and particularly without danger of overheating the metal adjacent to the weld. The operation is extremely rapid, thus very economical and renders the salvage of defective castings a simple and very inexpensive procedure.

The new rod has shown itself to be extremely successful in the addition of metal on faulty or improperly machined castings, overlaying of surfaces which have been improperly cast, filling of "low spots," changing of aluminum patterns already machined, filling of faultily drilled holes, filling and overlaying of porous castings and welding of casting to aluminum sheet.

Another field where the appearance of this new electrode will greatly simplify

VICTOR

ARMY E NAVY

Some jobs are done best by the electric arc and others by the welding torch...but the universal tool for the preparation of iron and steel is the cutting torch.
VICTOR Cutting Torches offer a great many proved advantages, among which are their outstanding ability to safely withstand the hard usage and occasional abuse of speedy war production.

VICTOR EQUIPMENT COMPANY
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– Photograph by courtesy of Marinship Corporation, Sausalito, California

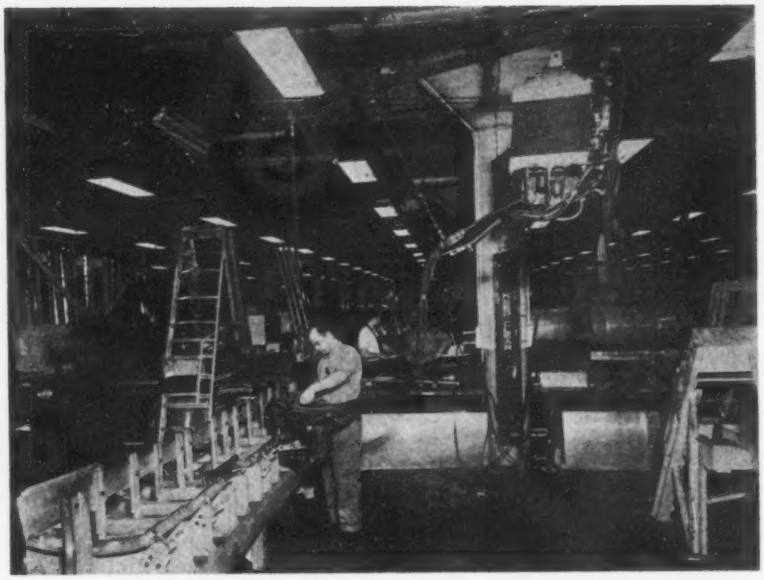
and speed up work is in the joining of aluminum sheet. The extremely high rate of fusion of this new type of rod produces a smooth, strong, homogeneous fillet with great speed, avoiding distortion and stresses. Joints can be obtained which are entirely leakproof and which are machineable and show high tensile strength comparable to the parent metal.

The rod is shielded with a special coating which permits its application even without preheating. It insures an even and rapid flow of metal and the slag can be removed by simply wire brushing the weld.

EutecTrode 2100 is a high-aluminum and low-silicon composition which alloys itself to practically every type of aluminum. Thus, it can be used for practically all aluminum jobs. EutecTrode 2100 is available in $^1/_8$-, $^5/_{32}$- and $^3/_{16}$- in. sizes and is recognized by a long blue tip. Material is available for prompt delivery. It is packed in packages of 25 lb.

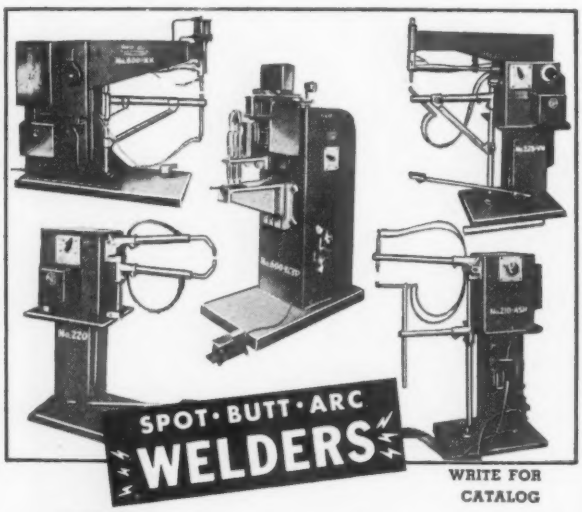
PORTABLE SPOTWELDER

The production of B-26 bomb-bay doors at the Glenn L. Martin Co., Baltimore, Md., already greatly speeded through the use of spot welding in place of riveting, has been further simplified and accelerated with the introduction of a portable spot welder to tack weld parts together in the assembly fixture. The new procedure cuts the number of operations in half and has reduced the time required to make the assembly by more than 50%.



An Employee of The Glenn L. Martin Co., Baltimore, Md., Tack Welds B-26 Bomb-Bay Door Assemblies with a New Portable Spot Welder Traveling on an Overhead Trolley

The portable spot welder consists of a spot-weld machine and transformer counterbalanced on a small beam pivoting from an overhead trolley traveling along a 50-ft. I-beam. The trolley is driven by a sprocket and chain powered by a $^1/_3$-



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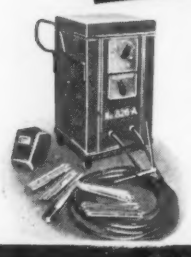

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WE INVITE CONTRACT SPOT WELDING IN LARGE OR SMALL QUANTITIES.

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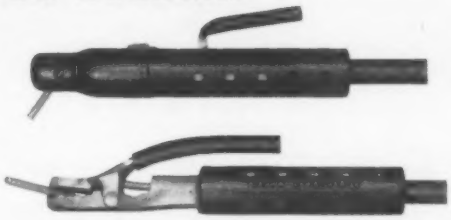
Fully Insulated Original "Hol-Grip" Electrode Holders in capacities of 150, 300, 500 and 600 Amps. Streamlined, Efficient, Easy one-hand Operation.

TWECO "Standard" plain jaw holders with fully insulated spring are tops in 300-400 amp range.



TWECO GROUND CLAMPS

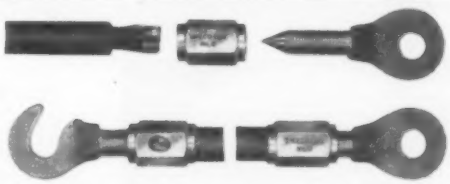
Tweco Red Head, the original ground clamp for heavy duty electric welding service. Gives a quick, positive and portable ground connection. Increases machine and operator efficiency. Helps to eliminate arc blow. Makes holders and cable run cooler, lasts longer. Cuts current consumption. Made of Special High Copper Alloy. Made in Midget, Junior, and Senior sizes.

TWECOLUGS

TWECOLUG principle is a tapered screw terminal wedging into a hollow seated body giving a positive connection without soldering. In case of cable breakage, field installation is quickly made.

TWECOLUGS are made heavy enough to stand abuse and will last the life of the ordinary welding machine.

Open type TWECOLUGS permit easy installation on machine terminals without completely removing wing nuts.



OPEN TYPE HOLE TYPE

Made of Special High Copper Alloy. Brass body of lug is hexagon for ease of holding while installing.

TWECO PRODUCTS

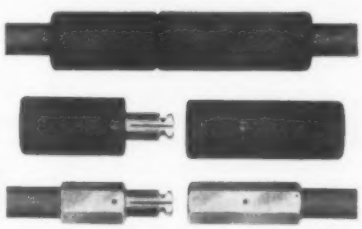
CONNECT WITH TWECO

The only *complete* line of Electrode Holders, Ground Clamps, Cable Connectors, and Cable Lugs on the market today.

★ ALL ITEMS READY TO SHIP

TWECO CABLE CONNECTORS

Tweco No. 1 and 2 "Sol-Con" Detachable Cable Connectors splice the range of welding cables from No. 6 through 4/0. Precision machined adjustable tension male plug easily toggles into reamed finish "pin-lock" female receptacle.



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TWECO PRODUCTS COMPANY

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Distributed in Canada by G. D. PETERS & CO. OF CANADA, Ltd. 1021 Birks Bldg., Montreal

DISTRIBUTORS ALL OVER THE UNITED STATES

hp. electric motor. A 200-kva. machine with a welding capacity of two thicknesses of 0.040 aluminum is used, and the arrangement permits it to operate over a large floor area, with spacers being provided on the I-beam to support the drive chain when the apparatus moves from the end of the beam.

Under the new procedure the skin, frames and stiffeners for the doors are all cleaned for spot welding and asembled in a fixture. They are then tack welded together with the portable spot welder and the entire assembly is carried to a floor-type spot welder for completion of the welding.

Before the introduction of the portable spot welder, it was necessary to first assemble the parts in a drill fixture where holes were drilled for skin clamps; then disassemble, clean and burr them for spot welding; put them together, fasten them with the skin clamps and spot weld them; and finally remove the skin clamps and drive rivets in the holes from which they were taken.

NEW LINCOLN CALCULATOR DETERMINES WELDING PREHEATING TEMPERATURES

A new calculator, designed for readily determining the welding preheating and interpass temperatures of steels in those few cases where experience indicates the need for preheating to obtain best welding results, has been announced by The Lincoln Electric Co., Cleveland, Ohio.

Calculator for Determining Welding Preheat and Interpass Temperature. Just Announced by The Lincoln Electric Co., Cleveland, Ohio

This useful calculator is $6\frac{1}{4}$ in. in diameter and consists of four movable sections of heavy cardboard stock. Complete instructions in the form of six simple steps are printed on the outside sections.

Although most steels are readily weldable and require no preheating because of low carbon and alloy content, this calculator will serve as a convenient guide in instances where steels have a higher content of carbon and other alloys and require preheating to minimize the tendency toward excessive hardening and possible cracking of the base metal adjacent to the weld.

The calculator, available through The Lincoln Electric Co., Cleveland, Ohio, is priced at 25 cents, postpaid, anywhere in the United States ($0.50), elsewhere.

X-RAY UNIT

Norelco Searchray 150, a complete, self-contained industrial X-ray unit which provides a quick, accurate means for nondestructive examination of specimens for internal flaws, cracks or foreign matter, is described in a new folder announced by North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.

The new 4-page illustrated folder tells how the Searchray 150 unit works, and lists its advantages and applications. Several Searchray photographs illustrate its use in X-ray examination of aluminum, steel, copper, hard rubber parts, plastics, die castings, small electrical parts, tubes, etc.

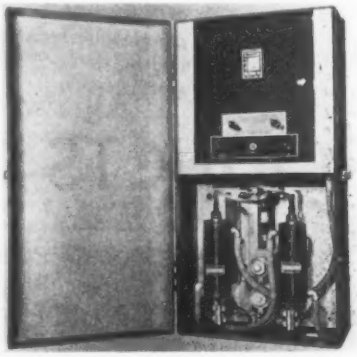
Searchray is inexpensive to install, is easy to operate and can pay for itself quickly in production and quality control savings. Controls are simple—the kilovoltage dial has scales calibrated for various thicknesses of aluminum, steel and brass—thus, even an inexperienced operator can quickly learn how to operate the device effectively.

A copy of this folder (S150) may be secured by writing North American Philips Co., Inc., 100 E. 42nd St., New York 17, N. Y.

"PACKAGED" ELECTRONIC WELD TIMER-CONTACTOR

Combination timer-contactor "package" units designed to provide the simplest, lowest cost, automatic, electronic control for resistance welders are announced by Weltronic Co., 19500 W. 8 Mile Road, Detroit 19, Mich. The new combination units may be used with new machines or to convert manually or cam-timed welders for automatic, electronic control. When used with air or hydraulically operated welders, the new "package" units eliminate inter-unit wiring simplify installation and maintenance and permit mounting of all controls on a machine if desired.

When used to convert welders to electronic control, they eliminate the variables normally associated with pneumatic type timers. When applied to cam-timed machines, no change in the machine is required, the electronic timing superseding the action of the cam timer. In addition, it is claimed that the new timer-contactor reduces materially the skill required to provide correct timing of welds, while providing material savings in installation time over other forms of electronic timers and contactors.



The new "package" units are so designed as to provide maximum flexibility of use. A universal wall or floor mounting cabinet houses any combination of interchangeable Weltronic N.E.M.A. type timers, together with a choice of Weltronic Ignitron or mechanical type contactors as required for the operation of the welder. Exclusive Weltronic plug-in type control panels permit the change from any N.E.M.A. type control to another for inspection or welder conversion in less than one minute, it is claimed. A single power supply unit operates all standard control panels from either 115-, 230- or 460-v. a.-c. lines.

The cabinet is $16\frac{1}{2}$ in. wide by 33 in. high and $10\frac{1}{2}$ in. deep, constructed for wall or floor mounting or mounting directly on the machine if desired. Synchronous timing and heat control may be added for complete machine control at any time without rewiring or scrapping any element of the basic timer-contactor controls.

NAVY AIRCRAFT WELDING FILM

The film "Aircraft Welding" produced by Walt Disney Productions for the U. S. Navy Bureau of Aeronautics has been made available to the AMERICAN WELDING SOCIETY for distribution to our local Sections and to manufacturers and users of welding equipment.

The film through photography and animated Disney drawings demonstrates principal methods of flame, arc and resistance welding of aluminum alloys and steel, the various techniques and precautions to be observed, and the Heliarc method of welding magnesium.

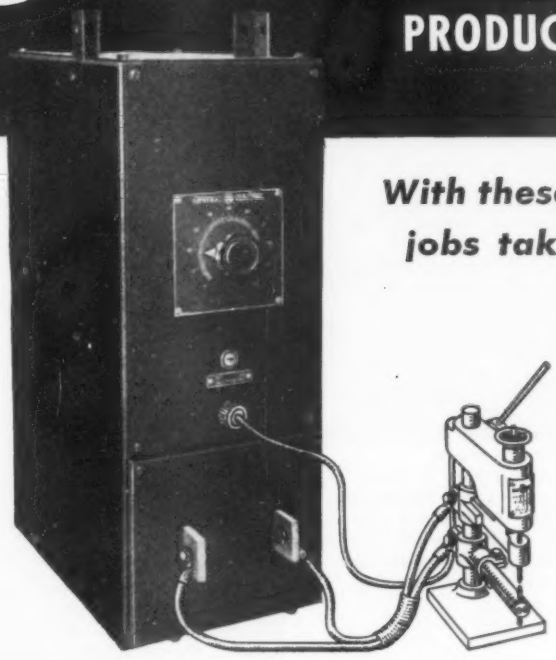
It has met with unqualified approval wherever it has been shown and should be a definite contribution and inspiration to the members of our Sections. The following comments are typical of those expressed by many well-known welding engineers:

"In all cases, the film has met an enthusiastic reception . . . viewing such a film should almost be considered a 'must' for anyone connected with the use of such equipment or the design of structures to use it."—J. H. Cooper, Chief Welding Engineer, Taylor-Winfield Corp.

"The reactions in all cases are extremely positive . . . the film is certainly one of outstanding caliber."—G. N. Seiger, Chairman of Advisory Committee, AMERICAN WELDING SOCIETY.

"Aircraft Welding" can be obtained for showing by requesting it from the Secretary, THE AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y. As only two prints (16 mm. sound) are in possession of the SOCIETY, it is advisable to request the film well in advance of your actual showing.

SAVE TIN AND SPEED UP PRODUCTION OF SMALL PARTS



With these resistance-welding controls, jobs take half as long as soldering

They cut down rejects by providing accurate control of current and time.

They save time by quick, finger-tip adjustment of current and time settings for different welding conditions.

CR7503-A133

This control panel, electrically the same as the CR7503-A136, but designed for wall mounting, has no transformer with it. Useful where space is limited, as the control can be remotely located.

CR7503-A136

This compact, half-cycle, thyratron control panel has a built-in transformer. It can be installed on, or mounted under, the assembly bench. A calibrated dial on the front of the panel provides easy adjustment of the weld time.

PRODUCTION rates are being stepped up more and more through the use of new and improved, electronically controlled, bench and tong welders. With these welders, the jobs that were impossible yesterday, are done quickly and easily today. With tin and time at a premium, many manufacturers who formerly used soldering have now turned to resistance welding. Another big advantage of resistance welding is that properly welded joints will not come apart at high temperatures.

NEW TONGS FOR THESE CONTROLS

These tongs are used with either of the half-cycle controls described when welding small parts in a restricted space. Especially suitable for welding solid or stranded wire to metals such as copper, brass, bronze, steel, ferrous alloys, etc. Tongs are equipped with replaceable tips, and will take other tips made by the user for individual needs. Flux or solder is unnecessary, and the pressure for the weld can be accurately adjusted on the pistol-shaped handle. The weld is made automatically when pressure is exerted on this handle.

RESISTANCE-WELDING CONTROL

Do these controls "fill the bill"?

If you would like complete information on these controls and welding tongs, send today for bulletin (GEA-3045). If these controls aren't the answer to your problem, let us know. We have a complete line of electronic controls for resistance welding. *General Electric, Schenectady 5, N.Y.*

BUY WAR BONDS

GENERAL ELECTRIC

545-2X-8960

SECTION ACTIVITIES

BOSTON

At the Annual Meeting held on April 17th at the Engineers' Club, Boston, the following officers were elected to serve for the year 1944–45.

Chairman, F. W. Davis, E. B. Badger & Sons Co.; *Vice-Chairman*, P. E. Kyle, Mass. Institute of Technology; *Secretary-Treasurer*, P. N. Rugg, Boston Edison Co.

Directors for two years: Allen Hogaboom, Walter Ovaska and George Richardson.

Trustee, H. G. Austin, Lukenweld, Inc.

The speaker at this meeting was Thomas Sutton, Chief Engineer, Welding Equipment & Supply Co., Detroit, who spoke on "Reclamation of Tools and Dies," and used many lantern slides to illustrate his talk. There were 113 attending the dinner, and 140 present at the meeting. This was the last scheduled meeting of the Section until fall.

CHICAGO

The Chicago Section had W. S. Loose, Supervisor of Joining and Corrosion Division, Metallurgical Dept., Dow Chemical Co., as its speaker for the April 21st meeting of the Section.

Mr. Loose delivered an interesting résumé of developments in the welding of magnesium alloys up to the present time. His discussion, though devoted primarily to inert gas-shielded arc welding included information on oxyacetylene and resistance welding of magnesium alloys.

The speaker supplemented his talk with a movie "The Working of Magnesium" and numerous slides. The evening was enlightened considerably by the active discussion which was carried on by the members and guests.

COLUMBUS

A Dinner Meeting preceded the Technical Session held on May 12th at the Southern Hotel. Two movies were shown. One on "Atomic Hydrogen Welding," shown through the courtesy of the General Electric Company, and the other on "Welded Steel Tubes" shown through the courtesy of Republic Steel Corp.

DETROIT

The First Annual Welding Conference of the Detroit Section was held the afternoon and evening of Friday, May 5th.

All of the papers at the afternoon session were very well presented and exceptionally well received. Under the very capable chairmanship of Robert E. Kinkead, they created a great deal of discussion.

The banquet and evening meeting were very well attended. Something in the neighborhood of 275 persons were present. The musical entertainment under the direction of Haze Bennett, and provided through the courtesy of the Ford Motor Co., was unusually good. Our National President, David Arnott, delivered a good inspirational address in behalf of the SOCIETY.

Dr. E. E. Dreese, Ohio State University, covered his subject "The Welded World of Tomorrow" most interestingly.

To add to the interest and pleasure in this meeting, our National Secretary, Miss M. M. Kelly, and the District Vice-President, Charles H. Jennings, were also present.

The following were the speakers and subjects at the afternoon session.

"The Upside-Down Welding of Boats," by W. E. Whitehouse, Defoe Shipbuilding Co.; "Induction Heating and Brazing," by James E. Ayres, Detroit Edison Co.; "Electronic Control of Gas Cutting Machines," by R. D. McComb, General Electric Co.

KANSAS CITY

The April meeting of the Kansas City Section was held Tuesday evening, April 18th, at Fred Harvey's Pine Room.

The speaker of the evening was E. B. Brown, Research Engineer of the American Brass Co., Detroit division.

Mr. Brown's subject was "Postwar Welding of Copper and Copper Alloys." An introduction to his subject was a colored, sound moving picture entitled "Copper Goes to War." This picture was produced by the American Brass Co.'s Canadian division, Anaconda American Brass Ltd. The picture illustrated the manufacture and many uses of copper and its alloys during peacetime and then the great effort of converting and expanding these manufacturing facilities for the thousands of wartime uses. Mr. Brown's discussion pointed out the many metallurgical problems and the solution of these problems in the welding and joining of copper and its many alloys.

LEHIGH VALLEY

The Lehigh Valley Seotion met on Monday, May 1st, at the Hotel Bethlehem for the final technical meeting of the 1943–44 season. Retiring Chairman H. W. Lawson voiced appreciation for the cooperation and interest shown by the 1943–44 officers and members before presenting the 1944–45 Chairman J. W. Kenworthy.

Before presenting the speaker, Chairman Kenworthy expressed the appreciation of the Section to retiring Chairman Lawson for his efforts and guidance during the successful first season of the Lehigh Valley Section.

The speaker of the evening was Bent Laune, Eastern Sales Manager for the Eutectic Welding Alloys Co. The subject was "Soldering, Brazing and Low Temperature Welding." Mr. Laune's talk was illustrated with slides and pointed out the value of low-temperature welding, particularly in connection with the repair of machine tools.

After the technical meeting a social hour, at which refreshments were served, was enjoyed.

LOS ANGELES

The Los Angeles Section announces the election of the following officers for 1944–45.

Chairman, Dave Bisbee, Rheem Mfg. Co., South Gate; *Vice-Chairman*, Charles Babbitt, Western Pipe & Steel Co.; *Secretary-Treasurer*., Ed Williams, Victor Equipment Co.

Directors: Cliff Sommerstrom, Art Wynn and William Powell.

The regular monthly meeting was held on April 20th, at Scully's Cafe. There were approximately 135 in attendance and the meeting was devoted mostly to Resistance Welding.

The first speaker of the evening was Dave Bisbee and his subject was "Mass Production Methods in Resistance Welding." He gave a very definite insight into production methods and the practical engineering necessary to adopt Resistance Welding to the production line.

The second speaker was John C. Silliman, Shop Superintendent of the Pacific Railway Equipment Co. Mr. Silliman's subject was "Sub-Contract Spot Welding" and he went into the engineering necessary to change a plant over to defense work.

"Production Methods and New Developments of Resistance Welding in Aircraft" were discussed by O. A. Perry, Assistant Process Engineer of Douglas Aircraft Co., El Segundo. Mr. Perry went into considerable detail to show construction methods used in ammunition boxes, chutes and carriers.

Summarizer for the meeting was Col. G. F. Jenks, Past-President of the AMERICAN WELDING SOCIETY. He brought out the salient points in each speaker's talk and commented on the fact that the talks were extremely interesting and held the attention of all the members until 11:45 P.M.

MARYLAND

Bela Ronay, Principal Welding Engineer, U. S. Naval Experiment Station, presented a talk entitled "Stress Development in Welding" at the April 21st meeting. About 70 members and guests attended.

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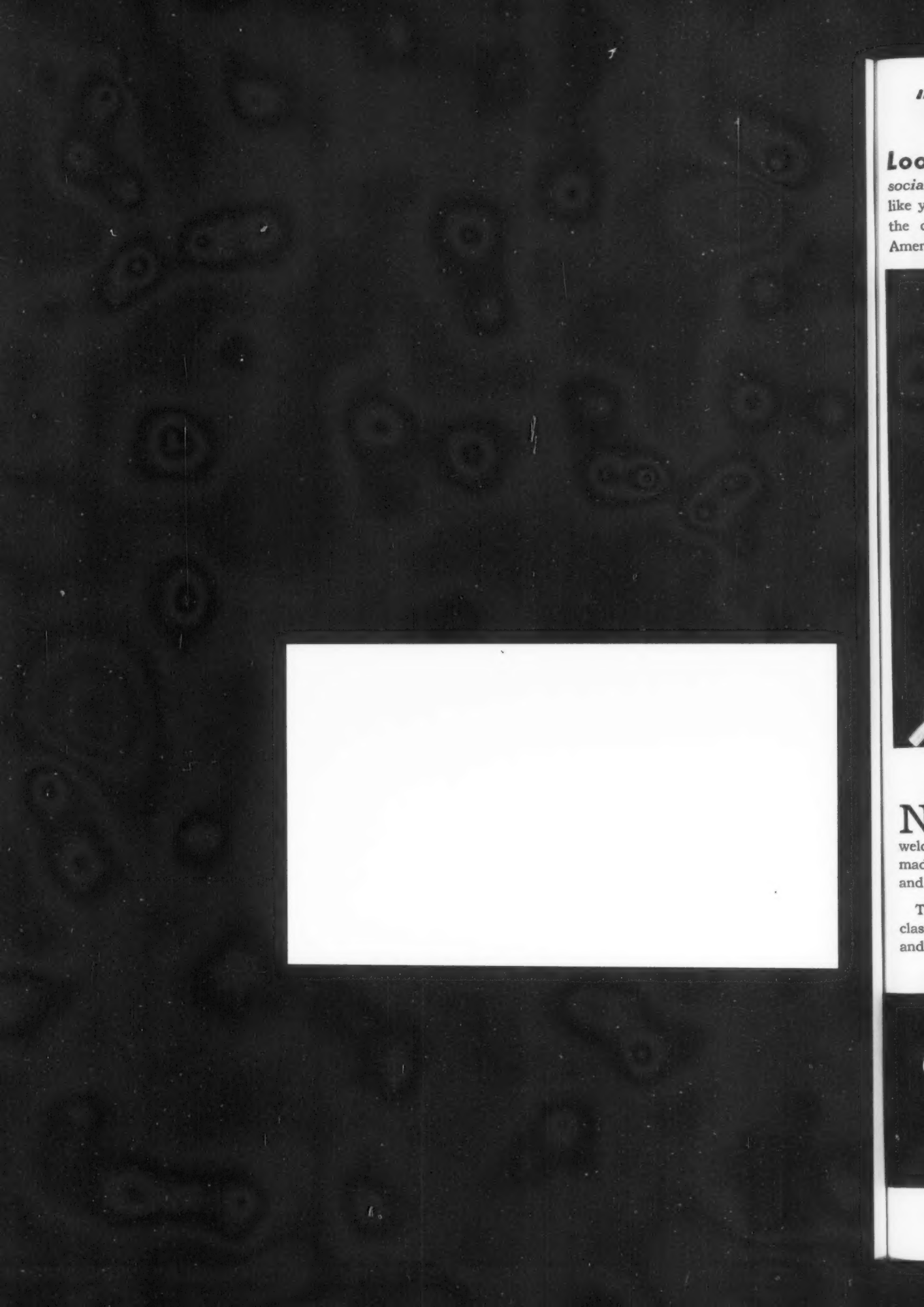
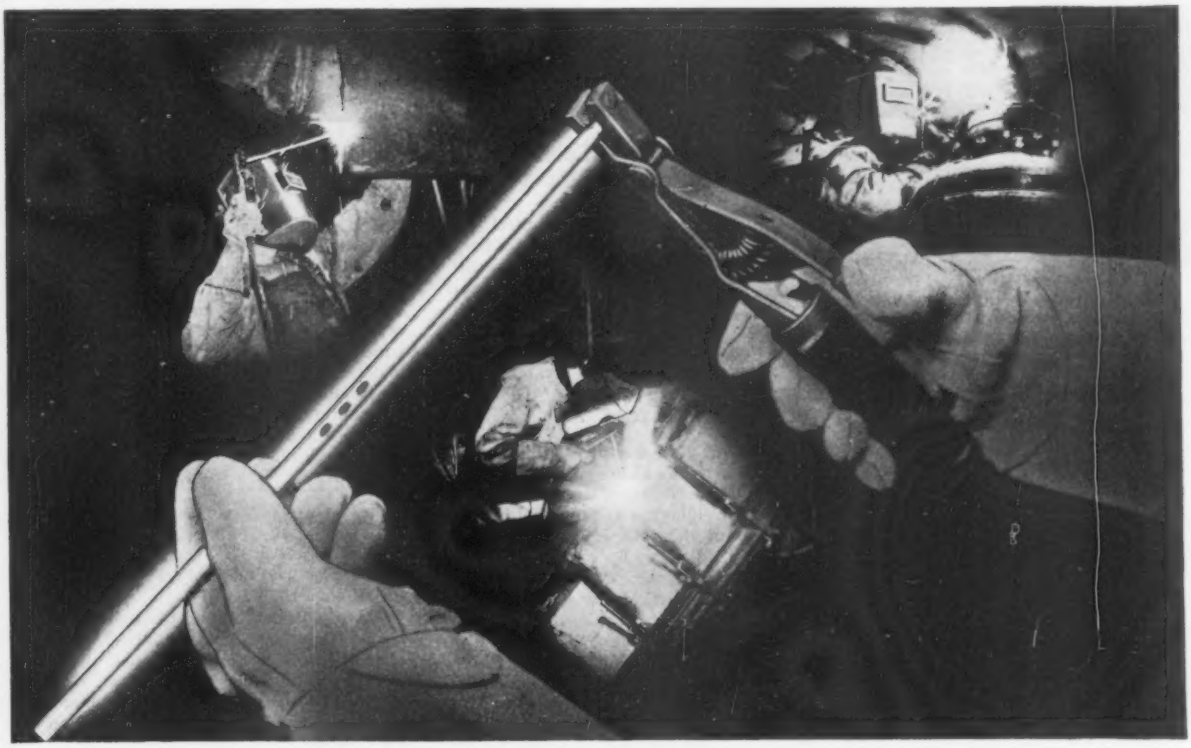


"Protected, Honored and Magnified"—*he says*

Look, Pierre, under your own or any *new social order,* a small group of soft-handed *theorists* like yourself could never give a *practical* answer to the challenge: "BUT HOW?" Yet under an old American *free enterprise* system . . . where protection, honor and magnification are in every man's grasp—*workmen* down in most metal working plants can themselves answer: *HERE'S HOW!!* (How to get MORE products. — How to get BETTER products. — How to get products AT A LOWER COST —so that more people can *afford* to buy).



HOW TO IMPROVE YOUR A. C. WELDING

NEW *"FLEETWELD 35"* . . . latest arrival to the "Fleetweld" family . . . brings to A.C. arc welding the same excellent performance which has made "Fleetweld" the standard of welding quality and economy in every field throughout the world.

This general purpose shielded arc electrode (A.W.S. class E-6011) for welding mild steel in flat, vertical and overhead positions is intended primarily for A.C. but also gives excellent results with D.C. It has a high burn-off rate and minimizes spatter and slag loss in all welding positions.

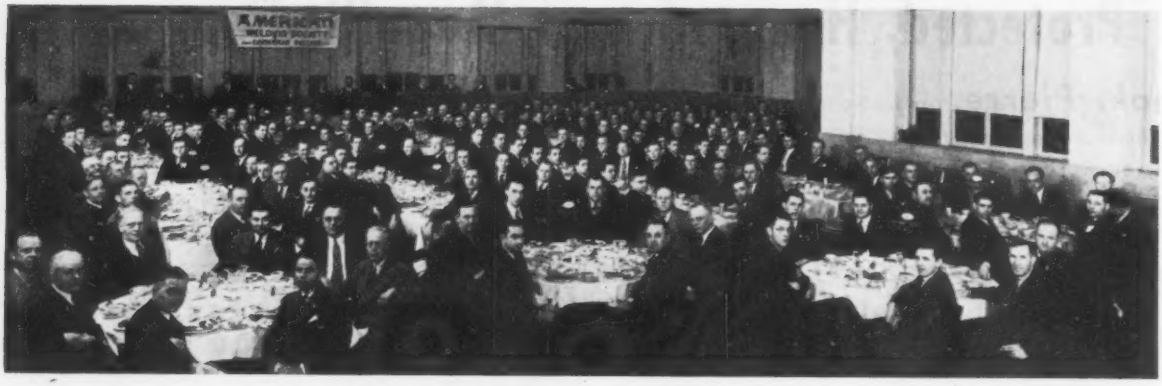
Properties of all weld metal specimens, as welded: Tensile strength 62,000 to 70,000 p.s.i.; yield strength 52,000 to 57,000 p.s.i.; ductility 23% to 30% elongation in 2".

Procedure will be sent free on request.

THE LINCOLN ELECTRIC COMPANY • Cleveland 1, Ohio

America's greatest natural **recourse**

ARC WELDING



March Dinner Meeting—Louisville Section

MILWAUKEE

J. W. Cable, Sales Manager, Induction Heating Co., Brooklyn, N. Y., presented the welding address on "Induction Heating and Its Application to the Joining of Metals," at the April 28th meeting of this Section. Mr. Cable's talk embraced a discussion of the fundamentals involved in induction heating and a detailed description of various processes which have been worked out.

MOBILE

The monthly meeting of the Mobile Section was held on April 13th at the Admiral Semmes Hotel. J. M. Tippet of The Linde Air Products Co., addressed a large gathering of members and friends at a dinner. His subject "Unionmelt Welding Process," was thoroughly enjoyed by an attentive audience. Mr. Tippet gave many illustrations in the various setups of Automatic Welding Processes.

NEW JERSEY

The regular monthly meeting was held at the Essex House, Newark, on April 18th. The usual dinner preceded the meeting with an attendance of 26. Over 80 members and guests attended the meeting, which was addressed by B. L. Wise of the Federal Machine and Welder Co. Mr. Wise presented an illustrated talk on "Resistance Welding." A film entitled "Resistance Welded Boiler Tubes" was shown in conjunction with the talk. At the beginning of the meeting a 30-minute question-and-answer period was conducted by J. B. Bagley, Welding Foreman of the Standard Oil Co.

NEW YORK

The Annual Meeting and Stag Dinner of the New York Section was held at the Building Trades Club, 2 Park Ave., New York, on Friday, May 5th.

The Annual Business Meeting and election of officers and members of the Executive Committee preceded the dinner and evening entertainment. The Teller's Committee reported the following elections for the 1944–45 season.

Chairman, G. V. Slottman, Air Reduction Sales Co.; *First Vice-Chairman* H. W. Northcutt, Bethlehem Steel Co.; *Second Vice-Chairman*, H. O. Klinke, Republic Aviation Corp.; *Secretary-Treasurer*, George Sykes, The Linde Air Products Co.

Members-at-large (term 3 years): J. L. Lufkin, J. L. Cahill, E. H. Roper and G. W. Place.

NORTHERN NEW YORK

The April 27th meeting of this Section was held at the Van Curler Hotel Solarium, Schenectady, N. Y. "Recent Developments in Welding" were presented by four members of the staff of Ricketts Laboratory, R.P.I. Dr. E. F. Nippes spoke on, "The Scientific Approach to Arc Welding"; Dr. A. Muller spoke on "The Spot Welding of Hardenable Steels"; F. J. Winsor, spoke on, "The Statistical Control of Spot Welding"; and R. A. Wyant spoke on, "Contact Resistance Measurements and Their Application to Resistance Welding Problems." All of the talks were very well received by the 90 members and guests present. A sound motion picture film "Life and Death of the *Hornet*" was enthusiastically received. This film is an unusual record of the life of the Aircraft Carrier *Hornet* from her birth to her gallant death.

NORTHWEST

The last two meetings of the Welding Engineering Course conducted by the Northwest Section, were held on April 17th and April 19th. John Mikulak, Mechanical Engineer, Electric Machinery Mfg. Co., Minneapolis, spoke on "Analysis of Machine Design" at the April 17th meeting; while LaMotte Grover, Welding Engineer, Air Reduction Sales Co., New York, spoke on "Control of Welding Procedure and Details of Design for Ships, Bridges, Buildings, and Other Structures" at the April 19th meeting.

PEORIA

The regular April meeting of the Peoria Section was held on the 19th at the Jefferson Hotel, and was addressed by W. J. Poehlman, Chief Spectrographer of the A. O. Smith Corp., Milwaukee, on the subject "Spectroscopy Applied to Welding."

The meeting was attended by over 60 members and guests, who thoroughly enjoyed Mr. Poehlman's presentation of this relatively new and important subject. Mr. Poehlman had an unusually well-organized group of slides and illustrations which showed the use of the spectroscope in determining the reasons for irregularities in weldability of steel, among other things.

A motion picture "Salute to the Navy" was presented at the opening of the meeting through the courtesy of the Navy Department.

PHILADELPHIA

An A.W.S.-WPB Foreman's Panel Discussion was held on Friday, May 5th, at the Engineers' Club.

The Chairman of the Discussion was Harry J. Irrgang, Superintendent, W. K. Mitchell Co. Discussion leaders were: O. C. Frederick, Welding Engineer, General Electric Co., "Resistance Welding"; E. R. McClung, Welding Engineer, New York Shipbuilding Corp., "Shipyard Welding"; William Hendricks, Superintendent of Shops, Belmont Iron Works, "Structural Welding"; A. A. Holzbauer, Asst. Welding Engr., Sun Shipbuilding & Dry Dock Co., "Boiler and Pipe Welding"; and Fred Judelsohn, Supervising Engineer, Air Reduction Sales Co., "Gas Cutting."

PITTSBURGH

The results of letter ballot vote by the Pittsburgh Section show the following officers re-elected for the 1944–45 Season.

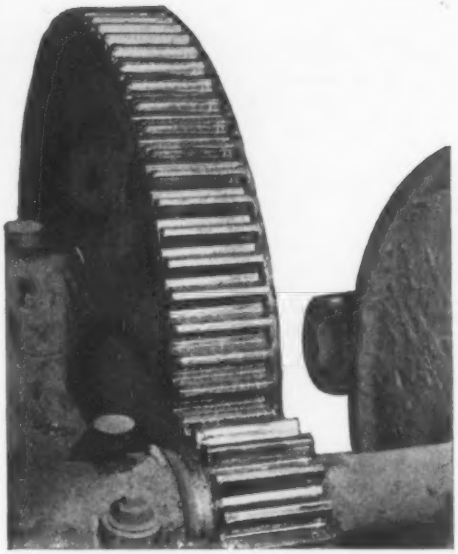
Chairman, Chas. H. Jennings, Westinghouse Elec. & Mfg. Co.; *Vice-Chairman*, G. O. Hoglund, Aluminum Co. of America; *Secretary*, J. F. Minnotte, Minnotte Bros. Co.

The following members were elected on the Executive Board for a two-year term: R. B. Lincoln, C. E. Loos and Donald H. Marlin.

The Seventh Annual Tri-State Welding Conference sponsored by the Pittsburgh Section of the AMERICAN WELDING SOCIETY and the Engineers' Society of Western Pennsylvania, was held on Friday, April 28th, in the Auditorium, Mellon Institute of Industrial Research. Opening Address was made by Dr. W. N. Jones, Director, College of Engineering, Carnegie Institute of Technology and President

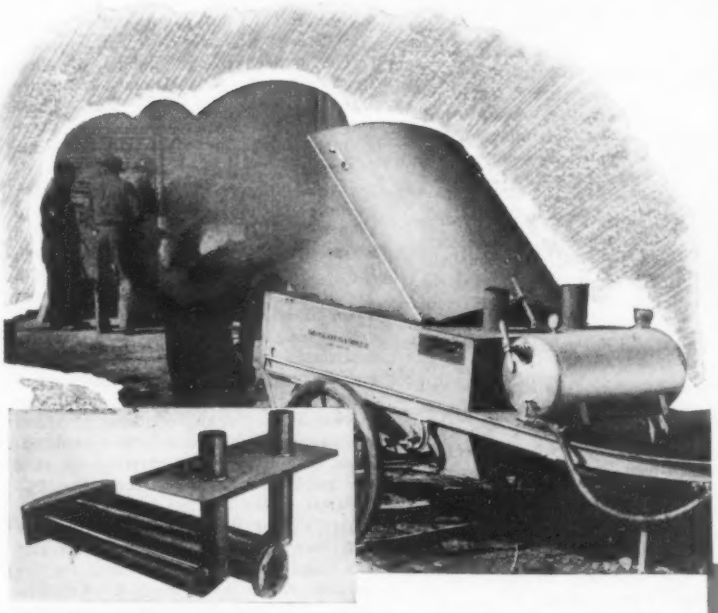
WE ANNOUNCE the addition to the Murex line of Type MA—the first true Grade E-7011 electrode. A general purpose rod, which handles easily in all positions, Type MA is designed primarily for A.C., but may also be used with D.C., reverse polarity. It deposits weld metal of high tensile strength and can be used on Carbon-Moly. and other 70,000 P.S.I. steels.

Further information on request.

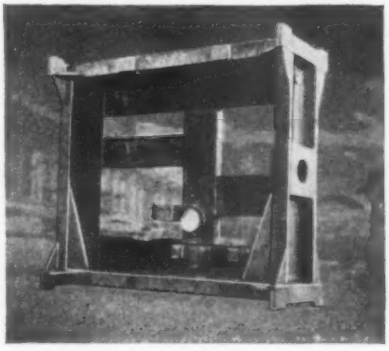


OPERATING INCHES deep in coal dust, these spur gears have been driving the mechanism for conveyor and cleaner cones since 1932. The gears are cut from Murex welded gear blanks, fabricated by Lukenweld, Inc. from rolled steel plate, which is free from blow holes, sand pockets or other internal defects sometimes found in poured blanks.

ELECTRODE RESEARCH and development work is carried on at the Metal & Thermit laboratory at Woodbridge, N. J. Raw materials, including the core wire and flux ingredients, are carefully analyzed in order to produce electrodes of certain pre-determined characteristics. Electrodes are tested for their operating and deposition characteristics and the quality of the weld metal.



IN THE MELTING OF ASPHALT, temperatures up to 2,000°F. are generated by the heat flue system, which is welded with Murex Electrodes by Littleford Bros., Inc. The melting kettles are also fabricated with Murex and, according to the manufacturer, the welds stand up under the terrific heat "exceedingly well."



THE MACHINE TOOL INDUSTRY speeds vital production through the use of arc welding. Other advantages of welded construction are ample rigidity with less weight than obtained with castings, and lower cost. The base illustrated was welded from flame-cut plates by The Dayton Fabricated Steel Co., with Murex Type FHP electrodes—"hot" downhand rods which produce sound, X-ray clean welds of high tensile strength and good appearance.

MUREX

ARC WELDING ELECTRODES

•

METAL & THERMIT CORPORATION

120 Broadway, New York 5, N. Y.

ALBANY • CHICAGO • PITTSBURGH
SOUTH SAN FRANCISCO • TORONTO

Specialists in welding for nearly forty years. Manufacturers of Murex Electrodes for arc welding, and of Thermit for repair and fabrication of heavy parts.

Engineers' Society of Western Pennsylvania. An illustrated address on "Fundamentals of Welding" was presented by Roy W. Emerson, Metallurgist, Pittsburgh Piping and Equipment Co. Mr. Emerson discussed some of the problems involved in welding and the application of these fundamentals in the fabrication of low-, medium- and high-alloy steel piping systems.

A "Get-Together" Dinner preceded the technical meeting at the Hotel Webster Hall. Dr. A. A. Bates, Manager, Chemical & Metallurgical Division, Westinghouse Elec. & Mfg. Co., presented an interesting talk on "South America."

PORTLAND

The organization meeting of the Portland Section was held Thursday evening, April 13th, at the Mallory Hotel.

One hundred twenty-five reservations were made for the dinner which preceded the meeting. The attendance was much more than had been anticipated, which resulted in many having to stand in the rear of the hall. The attendance was estimated at approximately 160.

The following officers were nominated and duly elected.

Chairman, E. L. Hann, Kaiser Co., Inc.; *Vice-Chairman*, Frank Ofner, Electric Steel Foundry; *Secretary*, Paul Kullberg, Industrial Specialties Co.; *Treasurer*, M. D. Westover, Monarch Forge.

The following members were elected to the Board of Directors: Arthur O. Brown, Tom Maloney, L. B. Voshell, G. E. Gunderson, Carl Lodell and H. E. Hopkins.

The principal speaker of the evening was P. F. Spaulding, General Superintendent of Steel Construction, Seattle-Tacoma Shipbuilding, Inc. (Tacoma Division). Mr. Spaulding's subject was "Sequence of Erection and Welding," as applied in his yard. Mr. Spaulding presented his subject with the aid of a blackboard in a non-technical and interesting manner.

The meeting was concluded with the showing of the official Navy film "Air craft Welding."

ROCHESTER

The May meeting of the Rochester Section was held on the 4th in the Lower Strong Auditorium, University of Rochester. Dinner at Powers Hotel, preceded the meeting. F. C. Fyke, District Vice-President was the guest at the meeting.

Forrest Waldo, Air Reduction Sales Co., spoke on "Welded Tube for Construction Purposes and Dam Cooling Systems." This talk covered the application of welded tube in the Grand Coulee and other large dam structures.

SAN FRANCISCO

On March 31, 1944, the San Francisco Section reached the high mark in its meetings. This was one of the most interesting and successful meetings ever held in this area.

The membership committee, headed by L. P. Henderson, is to be congratulated, and the officers and members of the Section wish to express their appreciation to the employees and management of the Wooldridge Manufacturing Co. and the Joshua Hendy Iron Works, of Sunnyvale, Calif., for their very excellent cooperation and the favors granted.

The evening and meeting commenced with a delicious dinner, served sumptuously in the Cafeteria of the Joshua Hendy Iron Works.

After dinner, the members proceeded to the plant of the Wooldridge Manufacturing Co.

The Wooldridge Manufacturing Co. put on a special swing shift to enable the SOCIETY to witness the various steps taken in the fabrication of gear blanks, ranging in size from the smallest to the largest diameter practicable. The welding on these gears is accomplished by the use of positioners and Unionmelt.

From the Wooldridge Manufacturing Co., the members proceeded to the plant of the Joshua Hendy Iron Works.

The trip through the Joshua Hendy Co. proved to be most interesting.

Joshua Hendy Iron Works is engaged in the manufacture of steam turbine and reciprocating engines, as well as rocket firing guns and Diesel engines.

The route through the plant was as follows: First, to the foundry, where the castings for reciprocating engines and Diesel engines are made, pickled and cleaned; then, to the machine shops where they have the largest planer on the Pacific Coast.

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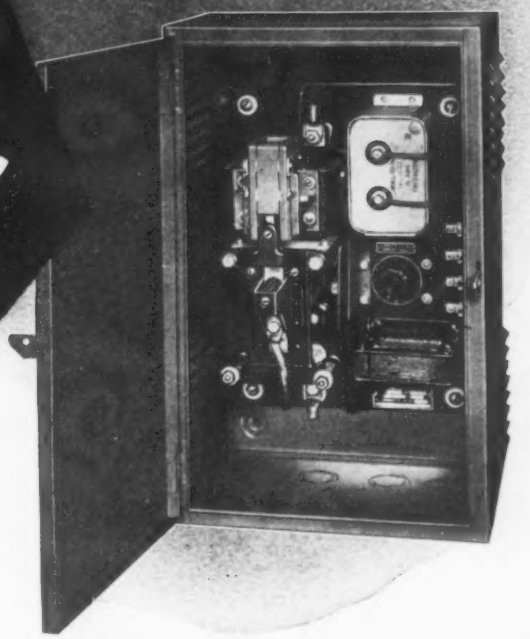
The meeting adjourned after the usual

FOR HIGHER RATINGS AND LONGER CONTACT LIFE

SQUARE D SYNCRO-BREAK RESISTANCE WELDER CONTACTORS



Arcing is eliminated at the contact tips of *SYNCRO-BREAK* contactors by separately energizing the magnet "shading coil" from a transformer and rheostat circuit. Correct rheostat adjustment causes the contacts to part as the alternating current wave approaches zero. Thus, the contactor interrupts zero current and no arc is drawn.

Elimination of arc heat at contacts increases allowable ratings and contact tip deterioration is reduced substantially. Rheostat adjustment is not critical and synchronization remains stable over long periods of usage.

Among the important mechanical design features which assure long, trouble-free service are: Hardened, knife-edge bearings for long life without lubrication. Solid contact supports to conduct away heat and relieve contact studs from impact strain. Low inertia moving parts and short contact gap, permitting consistent high-speed operation.

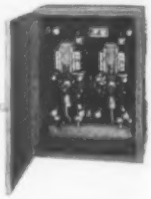
FOR FULLY AUTOMATIC CONTROL OF RESISTANCE WELDING MACHINES

Use Safront Weld or Sequence Timers with SYNCRO-BREAK Contactors or HIGH-SPEED Contactors

Available in 18 NEMA standard types with separate pneumatic timing relays for each step of the welding cycle. All electrically energized parts are placed behind a protective panel. Calibrated timer dials are adjusted from the front.

Notice attractive new flat-door cabinet construction which harmonizes with Safront timers. This design allows more interior wiring space without increasing overall outside dimensions. Syncro-Break contactors are single pole only.

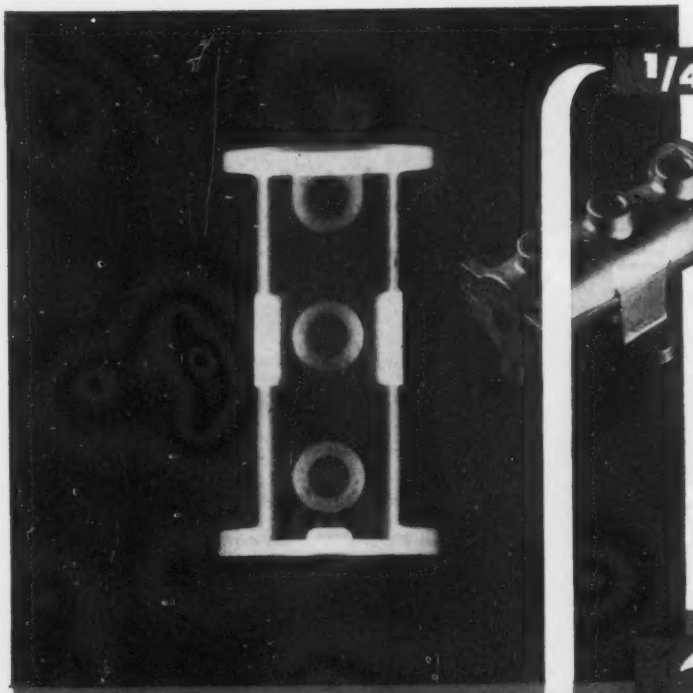
Available in either single or double pole, employing the same contactor construction as the Syncro-Break. High-Speed contactors without the synchronizing circuits are applied where operation is less frequent and loads are lighter.



ELECTRICAL EQUIPMENT • KOLLSMAN AIRCRAFT INSTRUMENTS

SQUARE D COMPANY

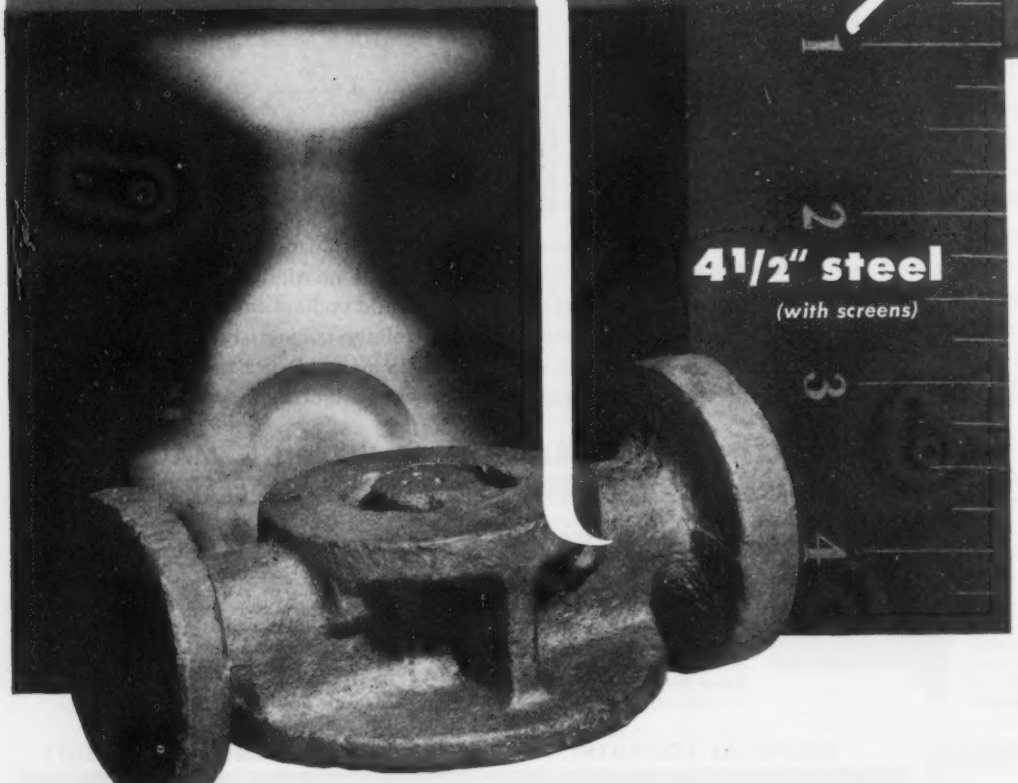
DETROIT • MILWAUKEE • LOS ANGELES



1/4" aluminum

The Picker 250 KV Industrial X-Ray Unit combines mighty radiographic power with precision control capable of delivering its radiation in a trickle or in a torrent with equal efficiency. This flexible voltage range provides, **in one machine,** complete facilities for radiographic inspection and control of a wide spread of diverse materials, densities, and section thicknesses. The power which can strike through bronze and 4½" of steel (with screens), is delivered under such precise control that it can be applied with equal facility and accuracy to the inspection of quarter-inch aluminum alloys.

this one machine's *Range* provide



First "E" Award in the X-Ray Industry

PICKER X-RAY CORPORATION
300 FOURTH AVENUE • NEW YORK 10, NEW YORK
WAITE MANUFACTURING DIVISION
17325 EUCLID AVENUE • CLEVELAND 12, OHIO

In this single Picker 250 KV X-Ray apparatus, many plants are finding the successful solution to the diverse problems encountered in an all-round radiographic inspection program. Its versatility of range is matched by its versatility of operation. The complete unit is available on a Mobile Chassis if inspection at different locations within the plant is required. Or it may be carried on a jib crane, or mounted on a dolly for heavy-duty work on boiler welds, pressure vessels, or similar massive objects. The entire tubehead-transformer assembly is so flexibly supported as to provide universal angulation in any plane, permitting rapid, accurate positioning in even the most awkward locations.

PICKER 250 KV INDUSTRIAL X-RAY EQUIPMENT

all-round facilities for x-ray inspection and control

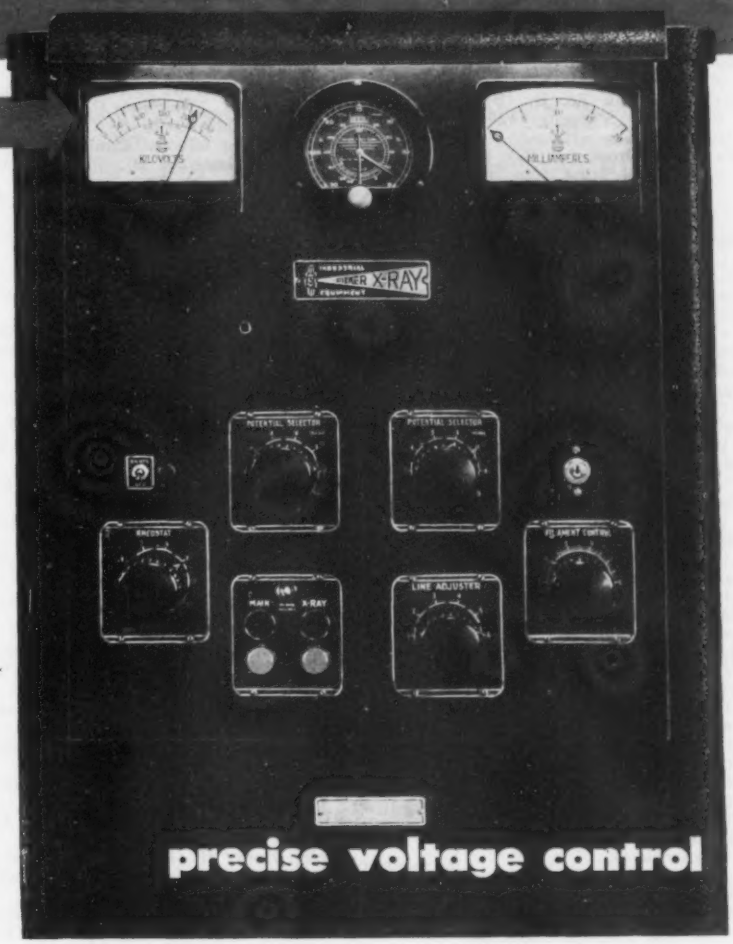
30 KVP to 250 KVP

accurately preset rigidly maintained

The Picker Control provides extremely close regulation of technique factors through a 100-step autotransformer and line voltage adjustor. An automatic timer with tube-use totalizer provides a timing range up to thirty minutes with fractional second subdivisions. Picker Bulletin No. 1144 gives complete specifications of this outstanding equipment. Write for it today.

industrial PICKER X-ray

The practical value of X-Ray control and inspection has been so conclusively proven that new applications in new fields are daily developments. Your local Picker engineer can keep you in current touch with them . . . he's a good man to see, often!



precise voltage control

Engineers' Society of Western Pennsylvania. An illustrated address on "Fundamentals of Welding" was presented by Roy W. Emerson, Metallurgist, Pittsburgh Piping and Equipment Co. Mr. Emerson discussed some of the problems involved in welding and the application of these fundamentals in the fabrication of low-, medium- and high-alloy steel piping systems.

A "Get-Together" Dinner preceded the technical meeting at the Hotel Webster Hall. Dr. A. A. Bates, Manager, Chemical & Metallurgical Division, Westinghouse Elec. & Mfg. Co., presented an interesting talk on "South America."

PORTLAND

The organization meeting of the Portland Section was held Thursday evening, April 13th, at the Mallory Hotel.

One hundred twenty-five reservations were made for the dinner which preceded the meeting. The attendance was much more than had been anticipated, which resulted in many having to stand in the rear of the hall. The attendance was estimated at approximately 160.

The following officers were nominated and duly elected.

Chairman, E. L. Hann, Kaiser Co., Inc.; *Vice-Chairman*, Frank Ofner, Electric Steel Foundry; *Secretary*, Paul Kullberg, Industrial Specialties Co.; *Treasurer*, M. D. Westover, Monarch Forge.

The following members were elected to the Board of Directors: Arthur O. Brown, Tom Maloney, L. B. Voshell, G. E. Gunderson, Carl Lodell and H. E. Hopkins.

The principal speaker of the evening was P. F. Spaulding, General Superintendent of Steel Construction, Seattle-Tacoma Shipbuilding, Inc. (Tacoma Division). Mr. Spaulding's subject was "Sequence of Erection and Welding," as applied in his yard. Mr. Spaulding presented his subject with the aid of a blackboard in a non-technical and interesting manner.

The meeting was concluded with the showing of the official Navy film "Air craft Welding."

ROCHESTER

The May meeting of the Rochester Section was held on the 4th in the Lower Strong Auditorium, University of Rochester. Dinner at Powers Hotel, preceded the meeting. F. C. Fyke, District Vice-President was the guest at the meeting.

Forrest Waldo, Air Reduction Sales Co., spoke on "Welded Tube for Construction Purposes and Dam Cooling Systems." This talk covered the application of welded tube in the Grand Coulee and other large dam structures.

SAN FRANCISCO

On March 31, 1944, the San Francisco Section reached the high mark in its meetings. This was one of the most interesting and successful meetings ever held in this area.

The membership committee, headed by L. P. Henderson, is to be congratulated, and the officers and members of the Section wish to express their appreciation to the employees and management of the Wooldridge Manufacturing Co. and the Joshua Hendy Iron Works, of Sunnyvale, Calif., for their very excellent cooperation and the favors granted.

The evening and meeting commenced with a delicious dinner, served sumptuously in the Cafeteria of the Joshua Hendy Iron Works.

After dinner, the members proceeded to the plant of the Wooldridge Manufacturing Co.

The Wooldridge Manufacturing Co. put on a special swing shift to enable the SOCIETY to witness the various steps taken in the fabrication of gear blanks, ranging in size from the smallest to the largest diameter practicable. The welding on these gears is accomplished by the use of positioners and Unionmelt.

From the Wooldridge Manufacturing Co., the members proceeded to the plant of the Joshua Hendy Iron Works.

The trip through the Joshua Hendy Co. proved to be most interesting.

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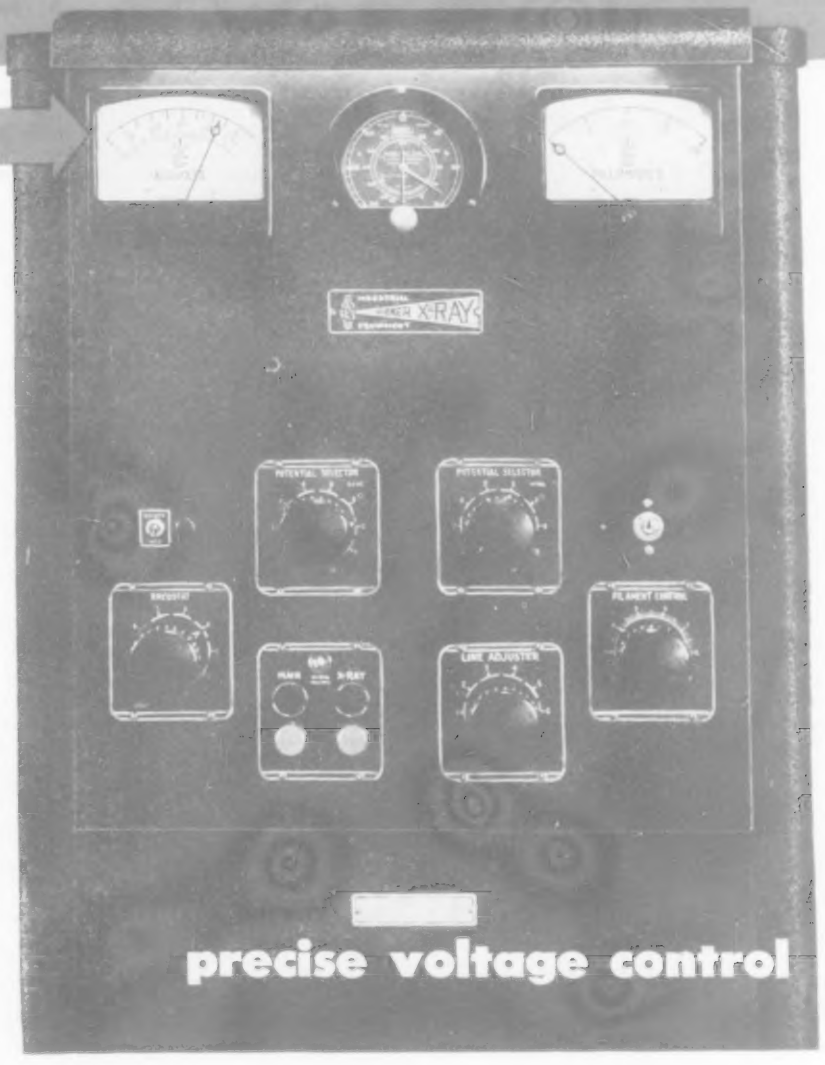
Industrial PICKER X-ray

The practical value of X-Ray control and inspection has been so conclusively proven that new applications in new fields are daily developments. Your local Picker engineer can keep you in current touch with them . . . he's a good man to see, often!



precise voltage control

serving of refreshments to all members and guests.

WESTERN NEW YORK

The March 24th meeting held at the Markeen Hotel, Buffalo, had an attendance of 25 at the dinner and 50 at the meeting. Elmer Isgren, Plant Manager, R. G. Le Tourneau, Inc., Peoria, Ill., spoke on "Arc Welding Used in the Building of Heavy Earth Moving Equipment." Mr. Isgren's talk was very well received. A motion picture film "Alcan Highway" was also very well received.

The April 28th meeting also held at the Hotel Markeen had an attendance of 24 at the dinner and 60 at the meeting. R. F. Helmkamp, Service Engineer, Air Reduction Sales Co., New York, spoke on "Recent Developments in Machine Gas Cutting." Mr. Helmkamp's talk was also well received by those present.

WICHITA

A special meeting was held on April 19th in the Aviation Room, Allis Hotel. E. B. Brown of the American Brass Co., Detroit, was the guest speaker. Mr. Brown's subject was "Postwar Welding of Copper and Copper Alloys." He also showed a 30-minute technicolor sound film "Copper Goes to War." Mr. Brown also had some samples of welded plates. The discussion was very interesting as he explained the various alloys used with copper and the physical properties that they added to the alloy.

YORK-CENTRAL PENNSYLVANIA

The May meeting held on the 10th at the Engineering Society of York Building, was addressed by Norman G. Schreiner of The Linde Air Products Co., who spoke on "Unionmelt in Industry." Mr. Schreiner's talk was illustrated with slides, following with a movie of the application of Unionmelt Process of Welding. Both the talk and the movie were very interesting.

List of New Members

April 1 to April 30, 1944

BOSTON

Austin, William M., (B) Austin Hastings Co., Inc., 226 Binney St., East Cambridge, Mass.
Brady, Thomas W. (C), 29 Athens St., N. Weymouth, Mass.
Douglas, Frank E., Jr. (B), American Bureau of Shipping, 126 State St., Boston, Mass.
Woodward, Preston E. (C), 49 Beal Rd., Waltham 54, Mass.

BRUNSWICK

Beckley, Frank C. (B), J. A. Jones Constr. Co., Brunswick, Ga.
Clements, Quincey (B), 3112 Reynolds St., Brunswick, Ga.
Costello, Dan (B), c/o J. A. Jones Constr. Co., Brunswick, Ga.
Cross, Francis E. (B), 4070 Wolf St., Brunswick, Ga.
Daniel, Giles R. (B), Box 254, St. Simons Island, Ga.
Dobbs, W. C. (B), J. A. Jones Constr. Co., Welding Dept., Brunswick, Ga.
Fite, Glenn A. (B), 2091 Cate St., Brunswick, Ga.
Goldin, Max (B), 222 Norman St., R. F. D. 1, Brunswick, Ga.
Hall, Oliver H. (B), J. A. Jones Constr. Co., Brunswick, Ga.
Harrell, James F. (B), 5108 Goodyear Homes, Brunswick, Ga.
Jones, Max W. (B), WA 14—586, Brunswick, Ga.
Klosterman, G. W. (B), Rt. 1, Brunswick, Ga.
Kratt, Emil J. (B), 1212 Palmetto Ave., Brunswick, Ga.
Mallett, K. L. (B), J. A. Jones Constr. Co., Welding Dept., Brunswick, Ga.
McGuffee, B. E. (B), c/o J. A. Jones Constr. Co., Brunswick, Ga.
McIlhenny, G. N. (B), 1005 Sidney Lanier Blvd., Brunswick, Ga.
Minchew, Leslie A. (B), 3891 London St., Brunswick, Ga.
Moxham, Egbert (B), Brunswick Marine Constr. Corp., Brunswick, Ga.
Muntz, J. Don (B), WA 17—47D, Brunswick Ga.
Myers, Franklin G. (B), c/o J. A. Jones Constr. Co., Brunswick, Ga.
Pellett, John D. (B), c/o J. A. Jones Constr. Co., Brunswick, Ga.
Penn, W. H. (B), 1206 Palmetto Ave., Brunswick, Ga.
Prather, Forrest W. (B), c/o J. A. Jones Constr. Co., Brunswick, Ga.
Schmucky, Martin J. (B), Demere Rd., Box 205, St. Simons Island, Ga.
Tryon, William D. (B), 3605 Emanuel Ave., Brunswick, Ga.
Welch, Earl H. S. (B), 2201 Cate St., Brunswick, Ga.
York, Jack L. (B), WA 14—Apt. 615, Brunswick, Ga.

CANADA

Hamel, Rene (B), Montreal Technical School, 200 Sherbrooke St. O., Montreal, Canada

CHICAGO

Conner, George A. (C), 47 E. 102nd Pl., Chicago 28, Ill.
Haynes, C. B. (B), 225 Webb St., Calumet City, Ill.
Malmgren, G. V. (B), 10323 S. Bell Ave., Chicago, Ill.
Sale, Frank A. (B), 1118 E. 65th St., Chicago, Ill.

CLEVELAND

Jewett, Merle H. (B), Ransome Machinery Co., 101 Prospect Ave. N.W., Cleveland 15, Ohio
Miles, Ray (C), 5182 Philip St., Maple Hgts., Ohio
Patton, Patrick J., Jr. (B), 21308 Beachwood Dr., Rocky River 16, Ohio
Ribley, R. J. (C), 716 Michael Ave., Lima, Ohio
Richards, W. (C), 5121 Anthony St., Maple Hgts., Ohio
Smith, Henry H. (B), American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Spehek, Albert H. (C), The Biggs Boiler Wks., Co., 1007 Bank St., Akron, Ohio

COLUMBUS

Myers, Carl O. (A), Natl. Bd. of Boiler & Press. Ves. Insp., 145 N. High St., Columbus 15, Ohio

CONNECTICUT

Giroux, F. J. (C), Westinghouse E. & M. Co., 36 Pearl St., Hartford, Conn.

DETROIT

Fitzpatrick, R. D. (B), 13874 Grand River, Detroit, Mich.
Woods, R. R. (C), 7991 Hartwick St., Detroit, Mich.

INDIANA

House, Raymond L. (B), Marmon Harrington Co., 1511 W. Washington St., Indianapolis, Ind.

KANSAS CITY

Baugh, Walter E. (B), Box 143, Bennington, Kan.
Blickham, John (B), Rival Mfg. Co., 15th St. & Wabash, Kansas City, Mo.

LEHIGH VALLEY

Benham, Arthur W. (B), Box 399, Reading, Pa.
Harrop, Edgar (B), 130—4th Ave., Phoenixville, Pa.
Matlock, Michael A. (C), 516 Franklin St., Reading, Pa.
Strimel, Franklin W. (B), 71 W. 5th St., Pottstown, Pa.
Taylor, Warren (C), 19th Street Vocational School, 19th & Early St., Allentown, Pa.

LOS ANGELES

Campbell, Robert J. (C), 417 S. Chester St., Compton, Calif.
Downes, Henry B. (C), 1720 Ontario, Burbank, Calif.
Fullmer, C. V. (C), 1119 Aragon Ave., Los Angeles 31, Calif.
Johnson, John J. (C), 301 S. Pearl St., Compton, Calif.

Now an Effectively COOLED OFFSET ELECTRODE

An entirely new design of offset resistance welding electrode which operates even cooler than conventional straight electrodes is now available from Frostrode Products.

With this electrode it is now possible to production-weld in previously inaccessible places such as close to flanges, etc. In this electrode refrigerated coolant is circulated within a small fraction of an inch of the entire contact surface of the electrode.

As in other "Frostpoint" electrodes, the new offset type is fitted with a quick removable and interchangeable cap, making the electrode proper a permanent machine unit. Only the cap need be changed instead of the entire electrode. Life is longer, too, since the effective cooling of the tip acts to prevent mushrooming (caused by softening of electrode metal under heat and pressure). The electrode is stronger, too, since it is solid at the "knee" (normally the weakest portion).

The new offset electrodes in ⅝ or ⅞ inch sizes will fit standard electrode holders. Only the tip is refrigerated. Water circulation can be retained in the balance of the machine if desired.

For complete details ask for Copy of Bulletin OP-44

There is a Frostrode standard refrigeration unit available for practically every resistance welding purpose. Typical models shown above are, at left, the Model No. 751 designed for zero welding with one light aluminum welder; Center, Model No. 3002, designed for electrode cooling of a 300 KVA steel welder; Right, Model No. 5001, designed for maintaining 0° F at electrodes of each of SIX aluminum welders. Ask for technical bulletins by model numbers.

FROSTRODE PRODUCTS

Originators of

Refrigerated Welding

19003 JOHN R ST. • DETROIT 3, U. S. A.

Robinson, Gaither E. (C), 6521 Southside Dr., Los Angeles 22, Calif.
Ryerson, David F. (C), 2424 Ashland, Santa Monica, Calif.
Whitman, L. W. (C), 3033 Fernwood Ave., Los Angeles 26, Calif.
Yates, George E. (C), 6222 Kraft, North Hollywood, Calif.

LOUISIANA

Schiele, Alvin E. (B), Hines Lane Wharf, Algiers, La.

LOUISVILLE

Porter, Richard T. (C), Linde Air Products Co., 2603 S. Floyd, Louisville, Ky.

MARYLAND

Payne, Ruth F. (C), U. S. Engineering Experiment Sta., Annapolis, Md.
Sincock, Harold E. (C), Reid-Avery Co., Dundalk, Md.
Symington, T. R. (C), Reid-Avery Co., Dundalk, Baltimore, Md.

MOBILE

Canulette, Walter N. (B), 107 S. Catherine St., Mobile 19, Ala.
Driscoll, W. H. (B), R. F. D., Wilmer, Ala.

NEW JERSEY

Bettes, William C. (C), 33 Union St., Ridgefield Park, N. J.
Bissell, George A. (B), Standard Welding Co., 313 Straight St., Paterson, N. J.
Bivaletz, John P., Jr. (C), 146 Wallington Ave., Wallington, N. J.
Eckert, Philip (C), 518—4th Ave., Haddon Hgts., N. J.
Feeley, George R. (B), Trinity Equip. & Supply Co., 261 Hurlbut St., Orange, N. J.
Gascoyne, Theodore (C), 205 Brighton Ave., Kearny, N. J.
Hanle, Edwin B. (B), Trinity Equip. & Supply Co., 261 Hurlbut St., Orange, N. J.
Horton, James R. (B), Trinity Equip. & Supply Co., 261 Hurlbut St., Orange, N. J.
Kinderman, William (C), 235 Bidwell Ave., Jersey City, N. J.
Kinnaman, Enos B. (B), 17 Fourth St., N. Arlington, N. J.
Kinney, Raymond T. (C), Hartford Welding Co., 111 Hartford St., Newark, N. J.
Robinson, Charles (C), A R T Welding Co., 1450 Chestnut Ave., Hillside, N. J.
Shaw, Frank B. (C), Hartford Welding Co., 111 Hartford St., Newark, N. J.
Steffens, G. Rudy (C), J. G. Germesshausen, Inc., 305 E. 3rd St., Plainfield, N. J.
Toman, George L. (C), Jersey Welding Supply Co., 343 E. 3rd St., Plainfield, N. J.
Weber, William (C), A R T Welding Co., 1450 Chestnut Ave., Hillside, N. J.
Yeh, Shu Tze (B), Chinese Government, 40 Wall St., Rm. 1335, New York 5, N. Y.

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Boltz, David C. (B), 25 Spruce St., Great Neck, L. I., N. Y.
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Hakun, Peter (C), 68 Croton Terrace, Yonkers, N Y
Olsen, Edgar H. (C), 1887 Cedar Ave., New York, N. Y.
Rittel, Roland J. (C), 660 Wilcox Ave., Bronx, N. Y.
Scott, Carlyle H. (B), 45 Marshwood Rd., Forest Hills, Long Island, N. Y.

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Willem, Frank N. (C), 2027 E. Larpenteur, St. Paul 6, Minn.

OKLAHOMA CITY

Minton, Clyde H. (C), Hobart Welder, Sales & Serv., 240 S. W. 44th St., Oklahoma City 9, Okla.

PEORIA

Stableton, Luther G. (C), P. O. Box 1139 80, Decatur, Ill.

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Colangecco, Florie (C), 331 W. White St., Summit Hill, Lansford, Pa.
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Harper, William E. (C), 2216 Locust Rd., Morton, Pa.
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Lorino, Attilio (C), 2843 Memphis St., Philadelphia 34, Pa.
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Smallwood, Robert H. (B), 4016 Dayton Rd., Drexel Hill, Pa.

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Mathews, Edward E. (B), Harris Calorific Sales Co. of Pgh., 339 Blvd. of Allies, Pittsburgh, Pa.
Vedder, Edwin H. (C), Westinghouse E. & M. Co., E. Pittsburgh, Pa.

PORTLAND, ORE.

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Bennett, Orville (B), General Delivery, Gresham, Ore.
Bohn, William R. (B), Box 1083, R. F. D. 1, Beaverton, Ore.
Bourn, Clyde M. (B), Box 565, West Lynn, Ore.
Brown, Arthur O. (A), Willamette Iron & Steel Corp., 3050 N. W. Front Ave., Portland, Ore.
Brown, Melville B. (B), 4052 N. E. 21st Ave., Portland 12, Ore.
Buhrer, Jack (C), Rt. 3, Box 215, Vancouver, Wash.
Bullard, Maurice L. (B), Oregon Shipbldg. Corp., Portland 7, Ore.
Clemmensen, C. W. (B), 616 N. E. Fargo St., Portland, Ore.
Clinton, Frank G. (B), 8938 N. Leonard St., Portland, Ore.
Creek, Roy (B), 4815 Washington St., Vancouver, Wash.
Dalton, J. Wylie (C), 7926 N. Chautauqua Blvd., Portland 3, Ore.
Field, Charles W. (B), 829B East 59th St., Vancouver, Wash.
Frieling, Henry (B), 5825 N. Delaware, Portland 11, Ore.
Gardiner, James E. (B), 2902 S. W. Sylvan Court, Portland 1, Ore.
Griffith, Harry S. (B), 5428 N. E. 35th, Portland 11, Ore.
Hann, E. L. (B), 6507 W. Mississippi, Portland, Ore.
Hayden, W. E. (B), Welding Apparatus & Repair, 30 S. W. 2nd Ave., Portland, Ore.
Helzer, John H. (B), 3817 N. E. 10th Ave., Portland 12, Ore.
Howell, Earl M. (C), Rt. 4, Box 570, Oregon City, Ore.
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Jeremiah, James E. (B), 7462 N. Westanna Ave., Portland, Ore.
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Knechtges, Ed (B), 3317—4th Plain Ave., Vancouver, Wash.
Lodell, Carl A. (B), 3581 N. E. Knott St., Portland 13, Ore.
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Miller, Francis P. (B), 7306 S. E. Raymond St., Portland 6, Ore.
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Ofner, Frank (A), Electric Steel Foundry Co., 2141 N. W. 25th Ave., Portland 10, Ore.
Pesznecker, Leo C. (C), 8038 S. E. Ogden St., Portland, Ore.
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Spisla, Louis A. (B), 9000 N. E. Union Ave., Portland, Ore.
Spofford, Lester R. (C), Fisher Bros. Co., Astoria, Ore.
Steiner, Ray A. (B), 6917 N. Olin Ave., Portland 3, Ore.
Stewart, Duncan (B), American Bureau of Shipping, Rm. 722 Board of Trade Bldg., Portland, Ore.
Stith, Charles E. (B), American Bureau of Shipping, Rm. 722 Board of Trade Bldg., Portland, Ore.
Terry, Frank F. (C), 879 S. E. Sandy Blvd., Portland 14, Ore.
Thibadeau, Bill P. (B), 7225 S. W. Borbett St., Portland, Ore.
Walling, August C. (B), 610 E. 68th, Mc Laughlin Hgts., Vancouver, Wash.
Westover, M. D. (A), Monarch Forge & Machine Wks., 2130 N. W. York St., Portland, Ore.

PORTSMOUTH

Bailey, Staylor W. (B), 5118 Sewells Point Rd., Norfolk 2, Va.
Barham, C. O. (B), 1501 Lansing Ave., Portsmouth, Va.
Barnette, Martie F. (B), 84 Dahlgren Ave., Portsmouth, Va.
Bergh, Alfred C. (B), 1515 Lincoln St., Portsmouth, Va.
Breeze, Crosby A. (B), 36 Fiske St., Portsmouth, Va.
Bunney, Ira I. (B), 213 Dale Homes, Portsmouth, Va.
Comer, Arthur G. (B), 13 Barney Pl., Portsmouth, Va.
Doar, W. St. J. (B), 12 Greenway Dr., Grove Park, Portsmouth, Va.
Dull, J. W. (B), 910 Wilson Rd., Norfolk, Va.
Ferguson, Joseph B., Jr. (B), R. F. D. 1, Box 246B, Portsmouth, Va.
Fields, Hal R. (B), 64 Aylwin Rd., Portsmouth, Va.
Floyd, Henry R. (B), 14 Benton Ave., Portsmouth, Va.
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Gatrell, Norbert E. (B), 322 Graydon Ave., Norfolk, Va.

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Hoal, Joseph W. (B), 204 E. 28th St., Norfolk 8, Va.
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Mann, Hugh E. (B), 719 Lenier Crescent, Portsmouth, Va.
Nance, E. S. (B), 38 Afton Pky., Apt. 7, Cradock, Portsmouth, Va.
Pollock, Ezekiel S. (B), 35 Burtis St., Cradock, Portsmouth, Va.
Pollock, William R. (C), 531 County St., Portsmouth, Va.
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Rowell, Edward C. (B), 118 Oregon Ave., Portsmouth, Va.
Rowland, Charles G. (B), 20 S. Fairview Circle, Portsmouth, Va.
Rundell, Loyd E. (C), 84 Nicholson St., Portsmouth, Va.
Schaffer, Wm. H. (B), 4920 Devonshire Rd., Norfolk, Va.
Schwerin, H. G. (B), 108 N. Seventh Ave., Portsmouth, Va.
Sumner, Samuel T. (B), 425½ High St., Portsmouth, Va.
Turner, George L. (B), Churchland, Va.
White, Joseph (B), 1706 Des Moines Ave., Portsmouth, Va.
White, Richard S. (B), 18 Stevens Pl., Portsmouth, Va.
Wilkinson, Jack R. (B), 612—4th St., Portsmouth, Va.

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Dickerman, Lucile S. (B), 5252—17th Ave., N. E., Seattle 5, Wash.

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Plane, Carl E. (C), 1331 Howard Rd., Rochester 11, N. Y.

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Pueschel, Fritz M. (B), 1727 Waverly Pl., St. Louis 4, Mo.
Vankrimpen, B. E. (B), Flori Pipe Co., 601 E. Red Bud Ave., St. Louis 1, Mo.

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Becker, Paul C. (B), Box 8, Mill Valley, Calif.
Callahan, Frank J. (B), 133 Arden Ave., S. San Francisco, Calif.
Cole, W. B. (B), 425 Victory Ave., S. San Francisco, Calif.
Hammer, Fred H. (B), 271 S. 25th St., 2-C, Richmond, Calif.
Strock, Clarence R. (C), 3415 Simmons St., Oakland, Calif.
Tabucchi, Charles R. (B), Western Pipe & Steel Co., S. San Francisco, Calif.
Van Horn, Lloyd F. (B), 120 Drake Ave., S. San Francisco, Calif.

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Evans, Robley D. (B), 1122 E. 53rd St., Savannah, Ga.

TOLEDO

Montrie, E. F. (B), Montrie Welding & Mach. Co., 5430 Stickney Ave., Toledo 12, Ohio

WESTERN MICHIGAN

Voorhorst, Chester H. (B), Purity Cylinder Gases, Inc., 574 S. Division Ave., Grand Rapids, Mich.

WESTERN NEW YORK

Smith, Geo. H. (B), Curtiss-Wright Corp., Plant No. 2, Dept. 272, Buffalo, N. Y.

YORK

Hess, William B. (B), Safe Harbor Water Power Corp., R. D. 2, Conestoga, Pa.

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Adams, Paris (C), Adams Welding Shop, P. O. Box 85, Spurgeon, Ind.
Ames, Harry M. (C), 17 High St., Portland 3, Me.
Chabot, Paul E. (C), 18 School St., Biddeford, Me.
Colby, Stephen H. (C), Mountainview Apts., Evans St., S. Portland, Me.
Francoeur, Raoul A. (C), 1A Decker St., Lone Creek Terrace, Portland 4, Me.
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Jordan, Ralph H. (C), 114 Harriet St., S. Portland, Me.
Kastner, Neal E. (B), R. D. 5, Box 26, Wheeling, W. Va.
Klaus, Henry A. (C), 249 Concord St., Portland 5, Me.
Landry, Carl A. (C), Bar Mills, Me.
Mc Donough, John F. (C), 193 South St., Gorham, Me.
Morin, Paul M. (C), 151 Stanford St., S. Portland, Me.
Richardson, Bernard O. (C), R. F. D. 1, Lisbon Falls, Me.
Smart, Irving O. (C), 178 Clinton St., Portland, Me.
Walp, Arnold H. (C), 26 Vaill St., Portland, Me.
Willis, Samuel A. (B), 27 Wood Rd., Cape Cottage, Me.

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During Month of April

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Bramley, Jack W. (from D to C), Main St., Boylston, Mass.
Harmon, Carl F. (from D to C), 40 Grand St., S. Portland, Me.

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Josenhans, John F. (from D to C), 11512 Wallace St., Chicago, Ill.
Litz, Frank (from D to C), 4034½ N. Ashland Ave., Chicago 13, Ill.

DETROIT

Takoushian, P. (from D to C), 190 W. Davison Ave., Highland Park 11, Mich.

INDIANA

Bossingham, Harold (from D to C), 418 S. Butler Ave., Indianapolis, Ind.

NEW JERSEY

Canavan, James J. (from D to C), 168 Bergen Ave., Kearny, N. J.
Norman, Lawrence (from D to C), 340 N. 7th St., Newark, N. J.

NEW YORK

French, R. L. (from D to C), 1 Kingswood Dr., Great Notch, N. J.
Peirano, Lester A., Cpl. (from D to C), A. P. O. No. 9210, c/o Postmaster, New York, N. Y.
Segelken, Charles F., Jr. (from D to C), c/o C. S. Welding Service, Millerton, N. Y.

NORTHERN N. Y.

Goggin, Dwight (from D to C), R. D. 1, Stillwater, N. Y.

PUGET SOUND

Halladay, Glenn C. (from D to C), 2643 Terrace Ave., Bremerton, Wash.

SAN FRANCISCO

Andersen, Claude R. (from D to C), 707 Seminary St., Napa, Calif.
Temple, Wesley D. (from D to C), 915 Slater St., Santa Rosa, Calif.

SOUTH TEXAS

Flannery, E. B. (from D to C), 6508 Pickens St., Houston, Tex.

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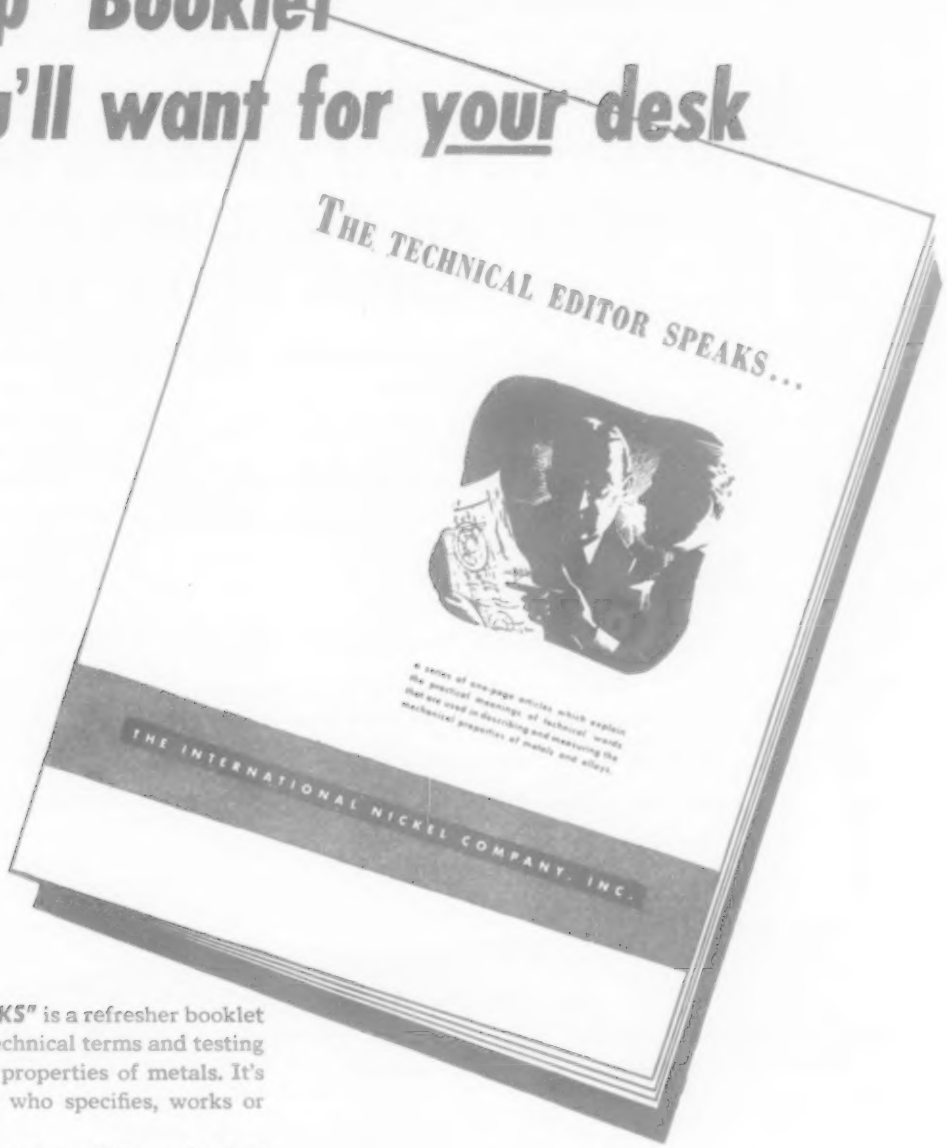

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TENTATIVE PROGRAM

TWENTY-FIFTH ANNUAL MEETING AMERICAN WELDING SOCIETY OCTOBER 16-19, 1944

HOTEL CLEVELAND, CLEVELAND, OHIO

MONDAY, OCTOBER 16th, Morning—9:30 A.M.

OPENING SESSION

Chairman—DAVID ARNOTT
President, American Welding Society

Vice-Chairman—E. V. DAVID
Chairman, Convention Committee

PRESENTATION OF MEDALS AND PRIZES

WELDING AIDS THE WAR EFFORT

Welding as an Aid in Shipbuilding Construction, by ADMIRAL H. L. VICKERY, U. S. Maritime Commission

*__Welding as an Aid in the Fabrication of Ordnance Equipment,__ by COL. S. B. RITCHIE, Office, Chief of Ordnance

Welding in Aircraft Construction, by W. B. STOUT, Consolidated Vultee Aircraft Corp.

* Acceptance not yet received

Monday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

WELDING AND CUTTING IN HEAVY INDUSTRIES

Chairman—R. J. YARROW,
Consolidated Iron & Steel Co.

Vice-Chairman—J. M. DRISCOLL,
Air Reduction Sales Co.

Heavy Oxyacetylene Cutting
by G. L. WALKER and H. G. HUGHEY, Air Reduction Sales Co.

Steel Mill Maintenance
by E. W. GRUBER, Wheeling Steel Corp.

Ordnance Welding and Cutting
by C. M. UNDERWOOD, Northern Ordnance, Inc.

RAILROAD AND TRANSPORTATION

Chairman—I. W. SHEFFER,
American Car and Foundry Co.

Vice-Chairman—A. G. OEHLER,
Associate Editor, Railway Age

Additional Bus Miles Through Maintenance Welding
by W. A. DUVALL, The Greyhound Corp.

Welding of Aluminum Tank Cars
by A. H. WOOLLEN, Railroad Sales, Aluminum Co. of America

WELDABILITY

Chairman—A. B. KINZEL,
Union Carbide & Carbon Corp.

Vice-Chairman—C. H. JENNINGS,
Westinghouse Electric & Mfg. Co.

Discussion Weldability of Manganese Steel
by W. B. BROOKS, Cramp Shipbuilding Co.

High Tensile Manganese Silicon Steels for Welded Fabrication
by G. G. LUTHER and F. H. LAXAR, Naval Research Lab.

The Bead-Weld Nick-Bend Test for Ductility
by C. E. JACKSON and G. G. LUTHER, Naval Research Lab.

The Influence of Minor Variables on Weldability
by G. E. DOAN and R. D. STOUT, Lehigh University

Monday Evening—8:00 P.M.

ADAMS' LECTURE

Chairman—WENDELL F. HESS,
Rensselaer Polytechnic Institute

Vice-Chairman—R. H. ABORN,
United States Steel Corp.

C. A. Adams, Lecture, by DR. A. B. KINZEL, Union Carbide and Carbon Corp.

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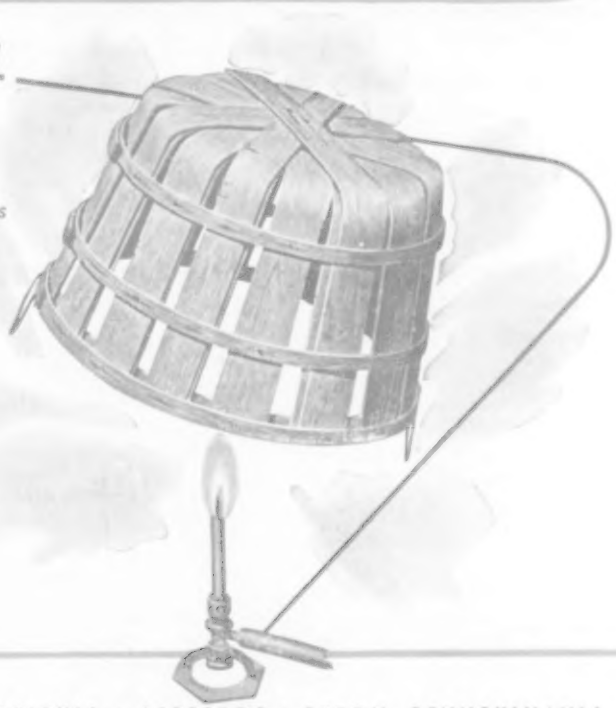

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TUESDAY, OCTOBER 17th, Morning—9:30 A.M.

THREE SIMULTANEOUS SESSIONS

RESISTANCE WELDING

Chairman—R. E. POWELL, Western Electric Co.

Vice-Chairman—G. N. SIEGER, S.M.S. Corp.

Spot Welding Machines for Heavy Gauges of Ferrous and Non-Ferrous Metals
by MARIO SCIAKY, Sciaky Bros.

Heat Transfer Across Contact Surfaces
by W. B. KOUWENHOVEN, Dean, School of Engineering, Johns Hopkins University

Roll Spot Welding
by B. L. WISE, Federal Machine and Welder Co.

Problems in Spot Welding Heavy Mild Steel Plate
by F. R. HENSEL, E. I. LARSEN and E. F. HOLT, P. R. Mallory & Co., Inc.

RESEARCH

Chairman—H. C. BOARDMAN, Chicago Bridge & Iron Co.

Vice-Chairman—G. F. JENKS, North American Aviation

The Effect of Postheating in Welding Medium Alloy Steels
by M. A. PUGACZ and G. J. SIEGEL Naval Research Laboratory

Stress Relieving Study
by PROF. J. R. STITT, Ohio State University

Metallurgical Effects of Welding on Fatigue
by W. H. BRUCKNER, University of Illinois

STRUCTURAL

Chairman—A. S. LOW, The Austin Co.

Vice-Chairman—J. F. MAINE, Republic Structural Iron Works

Standard Details for Welded Building Construction
by H. W. LAWSON, Bethlehem Steel Co.

Structural Welding
by FRED L. PLUMMER, Hammond Iron Works

Tuesday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

RESISTANCE WELDING

Chairman—L. C. BIBBER, Carnegie Illinois Steel Corp.

Vice-Chairman—H. C. COGAN, National Electric Welding Machine Co.

Low Reactance Cable for Resistance Welders
by MYRON ZUCKER, Mackworth G. Rees, Inc.

The Flash Welding of Alloy Steels—Welding Techniques and Variables
by J. J. RILEY, **Metallurgical and Physical Characteristics,** by J. C. Barrett, Taylor-Winfield Corp.

Small Portable Condenser Welding Set
by E. CALLENDER, E. G. Budd Mfg. Co.

RESEARCH

Chairman—S. L. HOYT, Battelle Memorial Institute

Vice-Chairman—G. V. SLOTTMAN, Air Reduction Sales Co.

Some Recent Developments in Stainless Steel Welding
by D. L. MATHIAS, Metal & Thermit Corp.

Bi-axial Fatigue Strength of Low-Carbon Steels
by GEORGE K. MORIKAWA and LeVAN GRIFFIS, Illinois Institute of Technology

Intergranular Corrosion of Stainless Steel Welds
by WM. T. TIFFIN, University of Oklahoma

Correlating Weldability and Jominy Hardness
by HOWARD SIMS, Black, Sivalls and Bryson, Inc.

SHIPS

Chairman—J. L. WILSON, American Bureau of Shipping

Vice-Chairman—S. J. MIDNIGHT, American Shipbuilding Co.

Welding in Ship Construction
by DAVID ARNOTT, American Bureau of Shipping

Welding as an Aid in Shipbuilding
by M. H. MacKUSICK, California Shipbuilding Corp.

Research Work with Reference to Ship Construction
by GEORGE MIKHALAPOV, War Metallurgy Committee, National Research Council

Welding in Ship Construction
by M. N. MALTSEFF, Western Pipe and Steel Co.

Multiple and Stack Machine Cutting
by A. H. YOCH, Air Reduction Sales Co.

Tuesday Evening—8:00 P.M.

UNIVERSITY RESEARCH CONFERENCE

WEDNESDAY, OCTOBER 18th, Morning—9:30 A.M.

TWO SIMULTANEOUS SESSIONS

AIRCRAFT

Chairman—G. S. MIKHALAPOV, National Research Council

Vice-Chairman—MR. DODGE, Sciaky Bros.

Aircraft Welding
by H. O. KLINKE, Republic Aviation Corp.

Helium Shielded Arc Welding of Stainless Steel Exhaust Collectors
by FRANCIS H. STEVENSON, Lockheed Aircraft Corp.

Multi-Arc Welding of Aluminum Alloys
by M. R. RIVENBURGH and C. W. STEWARD, Curtiss-Wright Corp.

Arc Welding in Aircraft
by H. E. SHAY, Douglas Aircraft Co., Inc.

RESEARCH

Chairman—ISAAC HARTER, Babcock & Wilcox Co.

Vice-Chairman—E. R. SEABLOOM, Crane Co.

Weldability-as-Rolled vs. Heat-Treat High Strength Constructional Steels
by LT. S. A. HERRES and W. L. WARNER, Watertown Arsenal

Stress Relief of Welded Joints
by PAUL C. CUNNICK, Lt. Col. Ordnance Dept., Rock Island Arsenal

Weldability Tests of Cast Steel
by C. E. JACKSON and F. S. McKENNA, Naval Research Lab.

Research on Electrodes
by D. C. SMITH, Harnischfeger Corp.

INTRODUCING...

The ALL WEATHER "BUMBLEBEE" for outdoor welding

Here's a rugged Wilson AC machine that is ideal for welding in exposed areas and wherever excessive moisture is encountered. Neither snow, sleet, nor rain hinders its reliable, efficient performance. Note these distinctive features:

- Fully protected against moisture by special moisture-proof insulation.
- All inside parts are protected by a heavy coating of moisture-proof paint.
- Enclosed in a sturdy weather proof case, finished in durable, outdoor enamel. Special gaskets and louvers prevent entrance of rain, sleet, snow, etc.
- Equipped with an automatic low-voltage contactor which instantly reduces open circuit voltage to approximately 40 volts. When the arc is struck, the contactor closes immediately, after which the performance of the transformer equals that of equivalent standard AC welders.

In all other details the All-Weather "Bumblebee" is identical to the standard-type Wilson "Bumblebee" AC machine. It offers the same operating advantages over equivalent DC welders – 15% to 30% more welding per work day, better quality welds, improved power factor, and easy maintenance. It is furnished either as a stationary unit or mounted on a sturdy, stamped-steel, 3-wheel carriage where portability is required.

The All-Weather "Bumblebee" is made in 300 and 500 amp. sizes. Other Wilson AC welders are made in sizes from 100 to 1000 amperes capacity. Mail the coupon for free catalog which gives complete details.

WILSON

WILSON WELDER and METALS CO., INC.

General Offices: 60 East 42nd Street, New York 17, N. Y.

In the U.S.A. WILSON AC WELDERS—*distributed through the Air Reduction Sales Company*

In Canada: G. D. Peters & Co. of Canada Limited, Birks Building, Montreal

Send for free Catalog

WILSON WELDER & METALS CO., INC.
60 East 42nd Street, New York 17, N. Y.

Gentlemen: ESB

Please send to me by return mail a copy of the "Bumblebee" AC Machine Catalog (ADW-53).

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ STATE _____

Wednesday Afternoon—2:00 P.M.

THREE SIMULTANEOUS SESSIONS

AIRCRAFT

Chairman—G. O. HOGLUND, Aluminum Co. of America

Vice-Chairman—E. S. JENKINS, Curtiss-Wright Research Lab.

The Geometry of the Spot Welding Tip and Its Relation to Tip Life
by E. D. CRAWFORD and C. W. STEWARD, Curtiss-Wright Corp.

Survey of Cleaning Practices for Spot Welding Aluminum Alloys
by F. M. MORRIS, Kaiser Cargo, Inc., Fleetwings Div.

An Evaluation of Process Control of Aircraft Welding
by P. H. MERRIMAN, The Glenn L. Martin Co.

Gas Shielded Arc Welding
by F. A. Wassell, General Electric Co.

MACHINERY

Chairman—A. E. GIBSON, Wellman Engineering Co.

Vice-Chairman—R. J. KRIZ, The James H. Herron Co.

Production Problems and Production Control
by E. C. BREKELBAUM, Harnischfeger Corp.

Inspection and Salvage of Machinery Weldments—Rough, Partially Machined and Machined
by JAMES W. OWENS, Fairbanks, Morse & Co.

Welded Jigs and Fixtures
by A. N. KUGLER, Air Reduction Sales Co.

Design of Welded Machinery
by JOHN MIKULAK, Electric Machinery Manufacturing Co.

PIPING AND PRESSURE VESSELS

Chairman—A. C. WEIGEL, Combustion Engineering Co.

Vice-Chairman—R. W. EMERSON, Pittsburgh Piping & Equipment Co.

Pressure Vessel Welding
by EDWARD B. McGUIRE, Hamler Boiler & Tank Co.

Effect of Normalizing on Welded Carbon-Molybdenum Pipe
by D. H. COREY, The Detroit Edison Co.

Welding of Dissimilar Metals
by E. C. CHAPMAN and R. E. LORENTZ, Combustion Engineering Co.

Welding of Layer Vessels
by H. H. NEEDHAM, A. O. Smith Corp.

Wednesday Evening—6:30 P.M.

Section Officers Dinner and Conference

THURSDAY, OCTOBER 19th, Morning—9:30 A.M.

THREE SIMULTANEOUS SESSIONS

PRODUCTION AND ORDNANCE

Chairman—J. F. LINCOLN, The Lincoln Electric Co.

Vice-Chairman—R. E. KINKEAD, Consulting Welding Engineer

Ordnance Specifications in Welding
by CAPT. J. F. RANDALL, Office of Chief of Ordnance, War Department

Welding of Clad Steel
by W. G. THEISINGER, Lukenweld, Inc.

FOUNDRY

Chairman—L. A. DANSE, Cadillac Motor Car Div.

Vice-Chairman—MR. BOLTON, Lunkenheimer Co.

Oxyacetylene and Arc Welding Practices in Steel Foundries
by FRANK KIPER and LAWRENCE GABES, Ohio Steel Foundry

Machine Cutting of Risers, Flame Scarfing to Remove Padding, and Flame Gouging to Remove Webs and Defects
by G. E. BELLEW, Air Reduction Sales Co.

Repair of Castings
by L. A. DANSE, Cadillac Motor Car Div., General Motors Corp.

MISCELLANEOUS

Chairman—W. E. CRAWFORD A. O. Smith Corp.

Vice-Chairman—A. L. PFEIL, Universal Power Corp.

Joining at Low Temperatures
by W. D. WASSERMAN, Eutectic Welding Alloys Co.

Developments in Metallizing
by WM. C. REID, Metallizing Engineering Co.

Metal Spraying by High Temperature Arc
by DR. ALEXANDER RIVA, Bendix Aviation

Thursday Afternoon—2:00 P.M.

Business Meeting

3:00 P.M.

Board of Directors Meeting

ANNUAL MEETING, A. W. S.

HOTEL CLEVELAND

CLEVELAND, OHIO

Make Reservations Early

Write to
Housing Committee,
National Metal Congress,
1604 Terminal Tower Bldg.,
Cleveland 13, Ohio

Mention American Welding Society